CONSEIL PERMANENT INTERNATIONAL POUR
L'EXPLORATION DE LA MER
CHARLOTTENLUND SLOT — DANEMARK

RAPPORTS
ET
PROCÈS-VERBAUX DES RÉUNIONS

VOLUME CV

3ÈME PARTIE
APPENDICES
(1936—1937)

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

Prix: Kr. 3.00.

. VIII 36

CONTENTS

Appendices to Reports of:

North Western Area Committee: Page

1. "Recherches Françaises faites dans le Secteur Nord-Ouest et particulièrement à Terre-Neuve depuis l'Année 1934" by L. Beaugé 3
10. "Variations of the Surface Temperature at Selvogsbanki, Iceland, during the Years 1895—1936" by Helge Thomsen 51

Combined North Sea Committee:

12. "Fluctuation and Oscillation in a Community of Pure Spent Herrings" by G. Gilson 63
13. "Observations on Length, Age Distribution and Growth of Herring in the Flemish Bight and off Dieppe 1936—37" by J. J. Tesch 68

Northern North Sea Committee:

2. "Die deutschen Arbeiten über den Hering in der nördlichen Nordsee während der Jahre 1931—35" by W. Schnackenbeck 5
9. "Untersuchungen über die Zusammensetzung der Heringsschwärme in der nördlichen Nordsee 1936" by Wilhelm Erdmann 42
11. "New Oceanographic Investigations in the Northern North Sea" by Jens Eggvin 56

Southern North Sea Committee:

3. "Racial Investigations on Herring Larvae in the South-Western Inlets of Holland" by J. J. Tesch. 7
4. "Similar Fluctuations in the Herrings of the East Anglian Autumn Fishery and certain Physical Conditions" by J. N. Carruthers and W. C. Hodgson 10
5. "A Note on Plaice Fluctuations in the Southern North Sea" by J. N. Carruthers 14
6. "Continuous Current Observations for Fishery Research Application" by J. N. Carruthers 16
8. "The Reduction of the Stock of Plaice in the southern Horns Reef Area through intensive Trawling in later Years" by Aage J. C. Jensen 40

Plankton Committee:

7. "Résultats d'une année de recherches quantitatives sur le Phytoplancton de Monaco" by Francis Bernard 28

Salmon and Trout Committee:

14. "The Protection of Sturgeon, Salmon and Sea Trout in the Vistula" by M. Siedlecki 72

Copenhague — Imprimerie Bianco Luno A/S.

1.

Recherches Françaises faites dans le Secteur Nord-Ouest et particulièrement à Terre-Neuve depuis l'Année 1934.

Par

Commandant L. Beaugé.

En 1934 l'Office Scientifique des Pêches Maritimes intervint personnellement dans les recherches exécutées dans la région américaine de l'Atlantique Nord par une croisière du navire océanographe "Président Théodore Tissier" en Septembre et Octobre. Les résultats de cette croisière font partie de l'exposé présenté par M. le Danois, Directeur de l'Office, dans le fascicule 2 du Tome IX (1936).

Si l'on s'en rapporte aux exposés que nous avons nous-mêmes présentés à diverses reprises au sujet des fluctuations de la pêche à Terre-Neuve, les années 1927—28 marquaient une époque de changement de situation dans les conditions de la pêche. La morue fuyait, pendant la période estivale, les Bancs du Sud pour remonter en plus grande abondance que de coutume dans la zone labradorienne, d'où résultait pour nos pêcheurs ce qu'ils appellent une année de "faillette".

Si nous laissons passer le maximum transgressif relatif de 4 ans et demi qui décale la poussée normale de la remontée estivale des eaux atlantiques vers le Nord, c'est au bout de neuf ans en 1936 et 1937 que le même phénomène, avec une activité plus ou moins notable, doit se reproduire.

L'année 1934 par contre était une année favorable, la dernière peut-être, à la présence de la morue en été sur les Bancs du Sud. Les cartes de température et salinités à 100 et 50 m. (pages 184 et suivantes du fasc. 2, Tome IX, *Revue des Travaux*) montrent en effet qu'en Septembre, c'est-à-dire avant la stabilisation hivernale, au moment peut-être du maximum transgressif, les fonds sont bons en de nombreux endroits des Bancs de Terre-Neuve. Les flèches cycloniques à 50 m. en particulier sont nettement caractéristiques, Pointe de 4 à 6° au Banquereau, sur le sud-ouest du Banc de St-Pierre, dans le Chenal entre Banc à Vert et Banc Baleine, vers le Platier (pointe double) correspondant à des salinités de 33 ou voisines, sont extrêmement favorables.

Ce phénomène concordait absolument avec les prévisions qui avaient été faites par l'Office et le "Président Théodore Tissier" eut l'occasion de vérifier au chalut la présence d'une abondance considérable de morue dans les endroits favorables, en particulier aux accores de l'est du Grand Banc, par fonds de 300 à 400 m. (pêcherie chalutière de Fécamp); sur le Grand Banc, (latitudes 44 à 45, longitudes 50 à 52, pêcherie malouine); pointe du Banc Baleine (lat. 45°, long. 55°, pêcherie du "Tissier"); Banc de St-Pierre (lat. 45° et 46°, long. 56°, pêcherie du "Tissier"); Banquereau (44° et 58° à 59°), Middle Ground, côte d'Halifax (pêcheries canadiennes et américaines).

Dans tous ces parages, abondance de poisson dans la zone définie par ses caractéristiques fondamentales comme "eau de morue".

En outre les recherches du navire l'amenèrent à découvrir une abondance considérable de très grosse morue dans les fonds du Golfe de St-Laurent par 300 m. et plus, dans une région jamais pêchée jusqu'à ce jour, et où la température était favorable, tandis que le long du Treaty Shore la saison était passée et il ne restait plus que très peu de poisson, sauf dans quelques rares ilôts littoraux que les pêcheurs achevaient d'épuiser et dont la morue ne pouvait sortir par suite de l'envahissement des eaux froides autour d'elle.

Année 1935. — La "Ville d'Ys" a effectué une coupe hydrologique par 46° de latitude Nord entre les longitudes 45° et 55°. La situation est caractérisée par une épaisse couche de 3°5 à 4° entre les longitudes 45 et 47, c'est-à-dire à l'est des Bancs sur une profondeur qui dépasse 400 m. Au contraire sur les Bancs l'eau froide est voisine de la surface. Le minimum de —1°5 est atteint par 75 m. de profondeur (longitudes 48° et 54° c'est-à-dire aux accores est et ouest). Ce sont là des signes connus. Eau polaire en couche trop mince, insuffisamment nourrie par sa source. La pêche sera obligée de remonter vers le nord pour trouver, l'été venu, une situation favorable.

Ces résultats nous sont confirmés par les pêcheurs. Le poisson abonde aux accores pendant le printemps et diminue jusqu'à disparaître, à peu près partout, en Juin. En Juillet l'eau blanche est signalée de 44°30 à 45°00 longitudes 50° à 51°.

Ce n'est qu'en Octobre, à la fin du mois, et en

Novembre que la morue revient vers le Platier du Grand Banc. La morue est alors fréquemment mêlée d'ânons dès que l'on arrive dans les eaux moyennes qui sont assez chaudes (4°5 à 50 m. et 6° à 25 m.).

Aussi les pêcheurs ont-ils mieux réussi cette année-là au Groënland que les années précédentes. Les températures (Fylla et Store-Hellefiske) sont très favorables (3° à 5°). Le poisson du Store-Hellefiske se tient aux accores ouest; plus près de terre il remonte vers la surface. Le lançon manque. La morue se nourrit en particulier de vers qui abondent.

Année 1936. — Pas de reconnaissance du Navire Océanographe dans la région. Les sources de documentation sont les sondages de la "Ville d'Ys" et les renseignements fournis par les pêcheurs.

Nous rencontrons exactement ce qui était prévu; le retour de la situation de 1927. D'un mot de Sir George Whiteley je tire la phrase suivante:

"Captain Bob Bartlett the well known arctic navigator reported that during this past summer ice conditions in Davis and Hudson Straits and in Smith's Sound were the lightest he had ever seen in all his years of arctic explorations. Water temperatures in Melville Bay were much higher than usual and practically no drift ice was encountered. Rather a remarkable tear of mild summer-like conditions in the whole of the Canadian Arctic and Baffin Bay."

Cette constatation s'accorde absolument avec les renseignements obtenus de nos pêcheurs. L'un d'eux me signale: Pas un iceberg cette année.

La pêche en conséquence a été très favorable pour les navires qui ont suivi les recommandations et avis de l'Office. Le capitaine Michelet du chalutier "Mercedita" a effectué la meilleure de toutes ses captures en répartissant son temps entre le Banc de Terre-Neuve et le Groënland. Ses résultats sont formidables: 35,000 quintaux. Le voilier "Zaspiakbat" signale 13,500 quintaux le 15 Août. Pêche mi-partie à Terre-Neuve et mi-partie au Groënland.

Une coupe de la "Ville d'Ys" entre Terre-Neuve et le Groënland est extrêmement caractéristique:

Elle est effectuée par une longitude moyenne de 52° entre les latitudes 51° et 67°. Dès 53° à 100 m. on entre dans l'eau chaude (plus de 3°5); la température est constante jusqu'à 400 m. A partir de 64° Nord la route arrive sur des petits fonds. On note 2°3 à 80 m. (lat. 64°), 1°7 par 90 m. (lat. 65°), 2° par 140 m. (lat. 66°), 4° par 30 m. (lat. 67°). Le poisson foisonne. Il faut aller assez près de la côte labradorienne pour trouver l'eau froide.

La situation est une confirmation éclatante de la périodicité du régime transgressif. Elle permet de faire sur la pêche prochaine des prévisions très nettes. Bonne pêche de printemps à Terre-Neuve. Mauvaise pêche d'été. Excellente pêche au Groënland pendant la saison. Les plus grandes chances d'avoir un été satisfaisant comme température et comme régime des vents.

Les quelques renseignements donnés ici sont extraits d'une note détaillée qui sera donnée à l'Office des Pêches avant le mois d'avril et sera vraisemblablement publiée au cours de l'année 1937.

2.

Die deutschen Arbeiten über den Hering in der nördlichen Nordsee während der Jahre 1931—35.

Von

W. Schnakenbeck.

Die von Deutschland durchgeführten Arbeiten über den Hering in der nördlichen Nordsee haben das Ziel, die biologischen Grundlagen der Heringsfischerei zu klären, um daraus für die Praxis erwertbare Erkenntnisse zu schöpfen. Um dieses Ziel zu erreichen, werden zwei Wege verfolgt, die parallel nebeneinander herlaufen, die jedoch vielfach miteinander verbunden sind.

1) Untersuchung der Fänge auf ihre Zusammensetzung nach "Biologischen Gruppen" (Rassen), Reife, Alter, Grösse.

2) Verfolgung des Ablaufes der Heringsfischerei.

Wenden wir uns zunächst der ersten Gruppe der Untersuchungen zu. Es ist ohne weiteres klar, dass alle drei Punkte dieser Untersuchungen aufs engste miteinander zusammenhängen und nicht voneinander zu trennen sind. Wenn hier der Ausdruck "Biologische Gruppen" gebraucht ist, so folge ich damit dem Beschluss, der auf der Besprechung in Lowestoft im Oktober 1935 gefasst wurde, wo man sich auf den Begriff "Biological Group" einigte. Das ist als ein Kompromiss anzusehen, weil man sich teilweise scheut, den Ausdruck "Rasse" zu gebrauchen. Anscheinend handelt es sich hierbei nur um einen Streit um Begriffe, im Grunde genommen sagt beides dasselbe. Gerade auf diese "Rassen"-Untersuchungen war aber von deutscher Seite grosser Wert gelegt worden, weil die Feststellung und Erkennung solcher "Biologischer Gruppen" eine Vorbedingung ist für die Möglichkeit einer einwandfreien Analyse der Fänge. Ob man nun diese natürlichen Einheiten "Rassen" oder "Biologische Gruppen" nennt, ist eine Frage von rein wissenschaftlicher Bedeutung, die für die Praxis an sich gleichgültig ist. Nur eins musste in diesem Zusammenhang zunächst grundsätzlich geklärt werden, ob natürliche, in sich geschlossene Gemeinschaften vorhanden sind und wie man sie erkennen kann. Dies war eine Aufgabe, die neben anderen einen wesentlichen Teil der deutschen Untersuchungen vor 1931 einnahm. Diese Untersuchungen wurden 1931 zunächst abgeschlossen und in zwei Veröffentlichungen zusammengefasst[1]).

Aus diesen Untersuchungen wurde die Schlussfolgerung gezogen, dass es beim Hering bestimmte, in sich geschlossene Laichgemeinschaften gibt, die sich auch durch gewisse morphologische Merkmale unterscheiden lassen. Allerdings besteht der Nachteil, dass nur eine kollektive Unterscheidung möglich ist, nicht eine individuelle. Als ein grosser Mangel hatte sich bei diesen Untersuchungen auch die Unzulänglichkeit der bisherigen Methodik in der Reifebestimmung herausgestellt. Eine genaue Reifebestimmung ist aber unbedingt notwendig.

Die bei diesen Untersuchungen in ihren morphologischen Merkmalen charakterisierten natürlichen Gemeinschaften waren als Rassen bezeichnet worden. Wenn man diesem Vorgehen nicht überall gefolgt ist, so ist die Begriffsfestlegung eine Sache von sekundärer Bedeutung. Uns erscheint der Begriff "Rasse" für eine natürliche, in sich geschlossene Fortpflanzungsgemeinschaft immer noch am treffendsten.

Zunächst traten aber bei den Arbeiten über den Hering nach Abschluss der genannten Untersuchungen die Rassenuntersuchungen etwas in den Hintergrund. Es wurden in den folgenden Jahren die Fänge hauptsächlich auf ihre Alterszusammensetzung untersucht. So liegen für die Fänge vom Fladengrund die Ergebnisse der Altersuntersuchungen nunmehr aus einer ganzen Reihe von Jahren vor. Allerdings beziehen sich diese Altersbestimmungen auf die Fänge in ihrer Gesamtheit. Da aber aus den Rassenuntersuchungen

[1]) W. Schnakenbeck: Entwicklungsgeschichtliche und morphologische Untersuchungen am Hering. Ber. Deutsch. Wiss. Komm. f. Meeresf. N. F., Bd. V, 2.
— Zum Rassenproblem bei den Fischen. Zeitschr. f. Morphol. u. Ökol. d. Tiere. Bd. 21, H. 3/4.

bekannt ist, dass sich die Heringsschwärme der nördlichen Nordsee biologisch aus zwei Hauptbestandteilen zusammensetzen, muss, um eine richtige Beurteilung der Alterszusammensetzung zu ermöglichen, die Altersgliederung innerhalb dieser beiden Bestandteile festgestellt werden. Das ist in den letzten Jahren auch geschehen, jedoch liegen die Ergebnisse dieser Untersuchungen noch nicht abgeschlossen vor.

Man sieht aber schon aus der Alterszusammensetzung der Gesamtfänge gerade der beiden Jahre 1934 und 1935 an der Unregelmässigkeit, dass hier besondere Einflüsse vorliegen müssen. Das wird um so deutlicher, wenn man zum Vergleich die Verhältnisse auf der Doggerbank heranzieht.

Schon bei den eingangs erwähnten Rassenuntersuchungen hatte es sich als unbedingt notwendig erwiesen, bei der Analyse der Fänge eine möglichst genaue Reifebestimmung durchzuführen, denn der Reifezustand ist eins der wichtigsten Kriterien bei der Trennung biologischer Gruppen. Gleichzeitig hatten sich aber auch die Schwierigkeiten gezeigt, die sich einer genauen Reifebestimmung entgegenstellten. Es wurde dann auch auf der Besprechung in Lowestoft (1930) empfohlen, eine Methode für eine zuverlässige Reifebestimmung auszuarbeiten. Nach dem Vorgang von Farran und Bowman wurde dann von Lissner versucht, auf dem gleichen Wege eine Bestimmungsmethode herauszuarbeiten. Wenn schon diese beiden Versuche voneinander abweichende Ergebnisse brachten, so erwies es sich in der Folgezeit notwendig, diese Frage nochmals zu überprüfen. Hierbei wurden die Untersuchungen nicht nur auf die Bestimmung des Verhältnisses von Gonadengewicht zu Körpergewicht beschränkt, sondern sie wurden auch auf die Bestimmung der Eizahl, des Volumens und der chemischen Zusammensetzung ausgedehnt. Diese von Erdmann seit 1934 durchgeführten Untersuchungen sind in ihrem vollen Umfange bisher noch nicht veröffentlicht, ihre eingehende Darstellung steht aber für die nächste Zeit bevor. Es ist jedoch auf der Kopenhagener Tagung im Jahre 1936 kurz über diese Ergebnisse berichtet[1]). Sie lassen sich dahin zusammenfassen, dass man auch auf diesen Wegen nicht zu einer genaueren Bestimmung der Reife kommen kann, als es durch das Äussere der Ovarien möglich ist. Auf die Schwierigkeiten, die für eine genauere Reifebestimmung bei den Männchen vorliegen, wurde ebenfalls hingewiesen, und besonders auf diese wichtigen Dinge wird Erdmann in seiner Arbeit näher eingehen.

Bei der Bedeutung aller dieser Fragen erwies es sich auch als notwendig, den Reifezyklus beim Hering eingehender zu untersuchen. Die Bearbeitung dieser Frage ist ebenfalls in Angriff genommen, befindet sich jedoch noch im Anfangsstadium, sodass darüber noch nichts näheres zu berichten ist.

Es war oben darauf hingewiesen, dass die viele Jahre durchgeführten Altersbestimmungen für die nördliche Nordsee andere Ergebnisse brachten als für die südliche Nordsee. Das ist auf die ganz verschiedene Zusammensetzung der Heringsschwärme in diesen beiden Gebieten zurückzuführen. Die ebenfalls wiederholt vorgenommenen Versuche, auf Grund der Fanganalysen Voraussagen über kommende Fangergebnisse zu machen, haben immer noch so grosse Unsicherheiten ergeben, dass mit einem Erfolg erst dann gerechnet werden kann, wenn die biologischen und im Zusammenhang damit auch die hydrographischen Grundlagen hinreichend geklärt sind. Dies ist mit ein Ziel der Arbeiten von deutscher Seite gewesen, in den letzten Jahren in verstärktem Masse. Da aber in der nördlichen Nordsee die Verhältnisse anders liegen als in der südlichen Nordsee, sind, um erst einmal für ein Gebiet Klarheit zu schaffen, seit 1934 in erster Linie die Untersuchungen in der nördlichen Nordsee vorgenommen.

Die zweite Gruppe der Arbeiten befasste sich mit regelmässigen Untersuchungen über den Ablauf der Heringsfischerei, und zwar sowohl der Fischerei mit Treibnetz wie der Fischerei mit Schleppnetz. Der zeitliche und örtliche Ablauf der beiden Zweige der Heringsfischerei wurde einerseits nach der Statistik verfolgt, wobei die im Laufe der Fangzeiten durchgeführten Fanganalysen zur Beurteilung des Fangverlaufes benutzt wurden. Andererseits wurden, wie das schon seit dem Jahre 1926 geschieht, an Bord der Logger Fangtagebücher geführt. Diese wurden dann nach Schluss der Fangzeit verarbeitet. Allerdings trat in der Zeit von 1931—33 in dieser Bearbeitung eine Stockung ein, jedoch wurde die Bearbeitung dieser Jahre nachgeholt[1]). Die Verwertung der Fangtagebücher erfolgte in der Weise, dass Monatskarten gezeichnet wurden, aus denen die Stärke der Befischung und Grösse der Fangerträge in den einzelnen Gebieten ersichtlich sind. Seit 1933 wurden auch Jahreskarten angefertigt.

Das Material für die Untersuchungen wurde teilweise aus Marktproben genommen, teilweise, und zwar in den letzten Jahren in steigendem Masse, auch auf See sowohl an Bord von Fischdampfern und Loggern sowie auf Fahrten mit Fischereischutzbooten gewonnen.

[1]) Rapp. et Proc.-Verb., Vol. 100, 2.

[1]) W. Erdmann: Die deutsche Grosse Heringsfischerei in den Jahren 1931—1934. Ber. d. Deutsch. wiss. Komm. f. Meeresf. N. F. VIII, 1.

3.

Racial Investigations on Herring Larvae in the South-Western Inlets of Holland.

By

J. J. Tesch.

On previous occasions (1) the occurrence of herring larvae in the south-western bays of Holland (Haringvliet and Oosterschelde) in early spring (March) has been mentioned; some material was examined then and vertebral counts executed. These studies, however, were not systematically carried on, as our chief aim was the young herrings (one year old) which were then, as now, largely caught for the use of their scales in the manufacture of artificial pearls.

Vertebral counts of such herring larvae were carried out on an extensive scale during the spring months of 1935 and 1936. To obtain the material we were wholly dependent upon the fishing industry in these waters, because the larvae in the Haringvliet (which make their appearance from the end of February onwards but are then of too small a size to permit the vertebrae being counted) were found clinging to the meshes of stow-nets — and in the Oosterschelde the only means of getting herring larvae was searching for them in catches of the weirs in the back-waters near the island of Tholen. Such weirs, however, are not used before April, and it is only during May and June that sufficient material can be obtained from them; at this time of the year the larvae, born in the previous autumn or winter, have metamorphosed into the scaled condition, and attained a length of 50—80 mm.

These circumstances account for the scarcity of our material in March, the very month in which the larvae have reached a size (of at least 35 mm.) the minimum at which counting of vertebrae is practicable. In both years it proved impossible to get material in April. This is regrettable, because in early spring only the chances are best to separate by their size the two races, to be expected in these waters, viz. North Sea herring and Channel herring.

The spawning periods of these races, as is well known, differ by two or at most three months only — and winter months at that. From the beginning of May onwards there seems to be a considerable overlapping of the broods, similar to that pointed out by Clark (2) in his discussion of herring larvae (of spring and autumn origin) near the east coast of Scotland.

The method of investigation was the following: the larvae of each sample were measured in mm., then one flank of the tiny fish was carefully removed, and the larvae were stained in alizarin after thorough washing. Frequency of the number of vertebrae was related, of course, to size of the fish, so that we got a frequency curve at each mm. length. It was then tried if it proved at all possible to find a "demarcation line" between the two races concerned. For practical purposes we used size-groups of 5 mm.

The following table contains these measurements.

Table I. **Sizes of Herring Larvae.**

Date	Number examined	Size-groups in mm.									Mean Size
		35—40	41—45	46—50	51—55	56—60	61—65	66—70	71—75	> 75	
18.III.1936	140	28	51	61	—	—	—	—	—	—	43·92
4.V.1936	400	115	207	74	4	—	—	—	—	—	42·75
5.V.1936	501	1	37	137	104	110	90	19	3	—	53·29
8.V.1935	2047	10	462	1097	467	10	1	—	—	—	47·99
9.V.1935	1548	1	39	398	794	295	21	—	—	—	52·60
9.VI.1936	1000	—	—	—	—	2	204	642	146	6	67·51
28.VI.1935	460	—	—	—	—	—	14	193	242	101	73·08

Table II. **Frequency of Vertebrae in Herring Larvae.**

Date	Number examined	Range in mm.	Frequency of Vertebrae 54	55	56	57	58	59	Mean of vertebrae ± stand. dev.	Remarks
18.III.1936	140	36—50	—	6	66	58	10	—	56·51 ± 0·058	North Sea herring
4.V.1936	400	35—54	—	13	137	220	30	—	56·67 ± 0·033	Mixture a)
5.V.1936	501	39—73	1	19	252	210	18	1	56·45 ± 0·029	North Sea herr., no subdiv. possible
8.V.1935	2047	39—61	—	64	871	1026	86	—	56·55 ± 0·014	North Sea herr. b)
9.V.1935	1548	40—64	—	54	641	793	60	—	56·55 ± 0·016	North Sea herr. c)
9.VI.1936	1000	60—76	—	22	447	494	36	1	56·55 ± 0.019	Mixture d)
28.VI.1935	460	61—86	—	11	222	216	11	—	56·49 ± 0·027	North Sea herr., no subdiv. possible
Grand total	6096	..	1	189	2636	3017	251	2	56·547 ± 0·008	

a) From 35—43 mm., in 237 larvae, the mean is 56·73. Channel herring.
From 44—54 mm., in 163 larvae, the mean is 56·57. North Sea herring.
b) There is some slight mixture of Channel herring in the larger sizes, for the larvae of 54 mm. and larger (59 cases) had an average of 56·61.
c) Here also there is some mixing of the two broods, but it is the smaller sizes, from 40 to 48 mm., with 146 ind. that have an average of 56·71 and are to be ascribed to the Channel herring, while the larger larvae (in 1402 cases, from 49 to 64 mm.) have the much lower mean of 56·54.
d) From 60—69 mm., in 766 ind., the mean is 56·52. North Sea herring.
From 70—76 mm., in 234 ind., the mean is 56·64.

There is not much to be seen from these series; at least no distinct bimodal character is to be detected. Of course measuring in mm. is likely to entail numerous mistakes and we must also allow for shrinking during some months in the preservative fluid (formalin), but even so it is difficult, without having recourse to vertebral counts, to explain away the small range in size in the sample of May 4th, while that of the next sample, taken one day later, has an extraordinarily large one (Table II.)

Referring to the next table, which contains the result of these countings it has to be borne in mind that the drawing of a boundary line somewhere must of necessity remain arbitrary. In some cases such a line could not be found at all, try as we might. Only in two samples (4.V.1936 and 9.VI.1936) there seemed to be a distinct mixture.

It seems, then, that in Haringvliet and Oosterschelde the larvae of the southern and later spawning branch of the autumn spawning North Sea herring which forms part of the Downs herring are largely predominant. It is useless to separate these two waters, in the light of later experience, as the herring larvae are swept indiscriminately into both these inlets by the strong tides. Whereas, however, in the samples of 4.V.1936 and 9.V.1935, the smaller individuals could be referred, to a certain extent, to the Channel race, as was to be expected, there are other cases, notably in the samples of 8.V.1935 and 9.VI.1936, in which the larger ones are referable (to some extent) to this type. Here we have a similar phenomenon, it would appear, as noted by Clark (p. 17—18): viz. that the winter spawned fish (of December—January) catch up on the slower growing larvae of autumn origin. This overlapping may take place already by the beginning of May.

In addition we may add some few notes on a particularity, especially discussed by Ford (3) of the tail vertebrae. In his interesting article he gives (p. 216—217) three cases of abnormalities in the number of dorsal processes of the two last vertebrae (excluding the urostyle) and divides these cases into three classes:

I. "Last" vertebra (n—1st) before urostyle with a duplication of the dorsal process (Fig. 4, A and B).
II. "Last" vertebra with an additional dorsal process, separated from the body of the vertebra by a deep cleft (Fig. 4, C and D).
III. "Last but one" vertebra (n—2nd) with a duplication of the dorsal process, sometimes accompanied by a duplication of the ventral process also, as occurs sometimes also in II (Fig. 4, E and F).

In examining one of our samples (of 9.VI.1936) of 1000 larvae some attention was given to this point (at least as regards duplication of dorsal processes[1])). We simplified the matter, however, in this way that we united Class II with Class I, so that only the cases were noted in which duplication of dorsal processes, either in the n—1st or in the n—2nd vertebra, occurred. We found the following percentage of abnormalities of this character:

[1]) The deep black pigment under the tail vertebrae of the larvae rendered the enumeration of the ventral processes of this part of the skeleton very difficult, so that we had to abstain from counting the elements that made up the "tail".

Table III. **Frequency of Duplication of Dorsal Process in two last Vertebrae before Urostyle.**

Number of vertebrae	55	56	57	58	59	Percentage of abnormalities
Frequency	22	447	494	36	1	
Normal %	1·6	35·5	44·1	3·5	0·1	
Abnormal % n — 1st	0·4	5·8	3·6	—	—	9·8
n — 2nd	0·2	3·4	1·7	0·1	—	5·4

Number of vertebrae	55	56	57	58	59	
"normal"	16	355	441	35	1	Mean 56·59
"abnormal"	6	92	53	1	—	— 56·32
						Diff. 0·27

We find a percentage of 15·2 of "abnormal" skeletons, rather lower than FORD (nearly 17·9). The "abnormality" of the duplication is to be found about twice as frequently in the n—1st as in the n—2nd vertebra, and about the same frequency is to be observed in the fishes with a given total number of vertebral bodies as well as in the whole series. FORD (who examined material of adult herrings from Smith Knoll, Plymouth and even from Norway, of different ages) found quite other percentages; out of 233 "abnormal" cases duplication of the n—1st vertebra (his class I and II taken together) occurred in nearly 89 %.

Finally, if we calculate the mean number of vertebrae, first in "normal" cases and then in the "abnormal" ones of our sample a wide discrepancy is stated.

It would appear from a note of FORD (p. 220) that adult individuals with duplication of the vertebral processes on either the one or the other of the two vertebrae before the urostyle show a greater tendency of fusion of centra in the vertebral column than normal ones, for out of 52 cases with fused centra no less than 23 exhibited these accessory processes in the tail. We can only say that fusion of vertebral bodies was extremely rare in our material, and we may assume that if such an abnormality happens to befall the individual it will only do so in later life and scarcely ever in the larval stage.

Literature cited.

1. TESCH, J. J.: Investigations on Herring in the Southern North Sea. Rapp. & Proc.-Verb. Vol. LIV, 1929.
2. CLARK, R. S.: Herring Larvae. The Mixing of the Broods in Scottish Waters. Rapp. & Proc.-Verb. Vol. LXXXV, III, 1933.
3. FORD, E.: The "Number of Vertebrae" in the Herring and its Variation. Journ. du Conseil, Vol. VIII, 2, 1933.

4.

Similar Fluctuations in the Herrings of the East Anglian Autumn Fishery and certain Physical Conditions.

By

J. N. Carruthers and W. C. Hodgson

(Fisheries Laboratory, Lowestoft).

The yearly forecasts for the fishery in question have been based on the ability to calculate the relative abundance of year-classes in a year n if the rate of mortality and the relative abundance of the year-classes in the year $n - 1$ are known.

The chief difficulty has always been in forecasting the 3-year-old herrings, because these have not been known as 2-year-old fish.

Herrings and Temperature.

It was thought that the year-to-year differences of water-temperature conditions under which the herrings are spawned and pass the earliest part of their lives, might be later reflected in the annual variations in abundance of 3-year-old fish. To test this, mean January water-temperatures based upon the observations made at the Varne Lightvessel were used, because the maximum spawning takes place in January and the Varne is the nearest point to the main spawning area for which data are available.

In Fig. 1 the temperature data for the different Januarys are plotted against percentage abundance of 3-year old herrings found in the catches three years later.

It is seen that there is a general parallelism between the two sets of data until we come to the January of 1933. Here the temperature falls considerably, but the 1932 year-class (appearing in the catches of 1935) was very much larger than that of the previous year. Thus after holding for nine years, the parallelism breaks down.

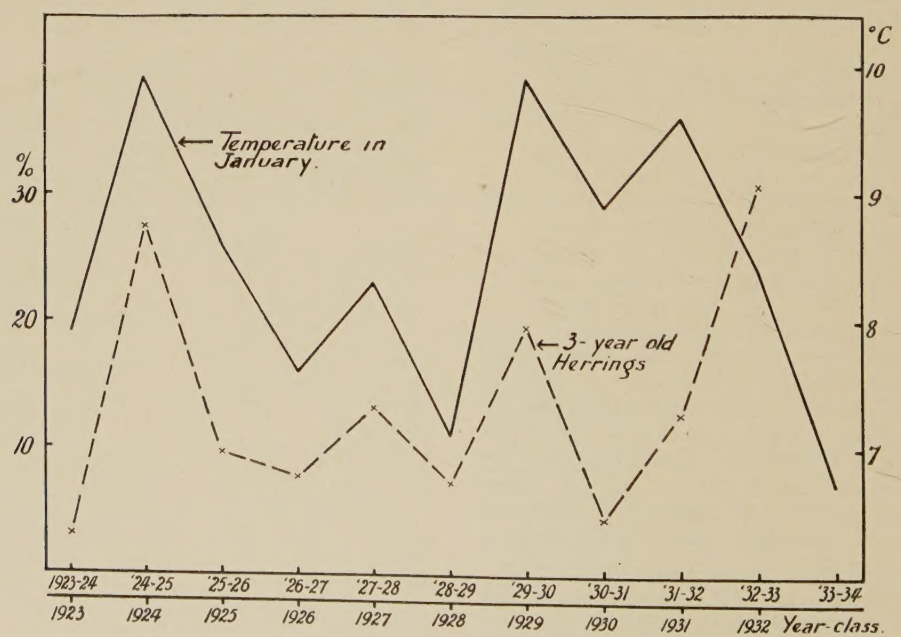


Fig. 1. Herring and Water Temperature at the Varne Lightvessel.

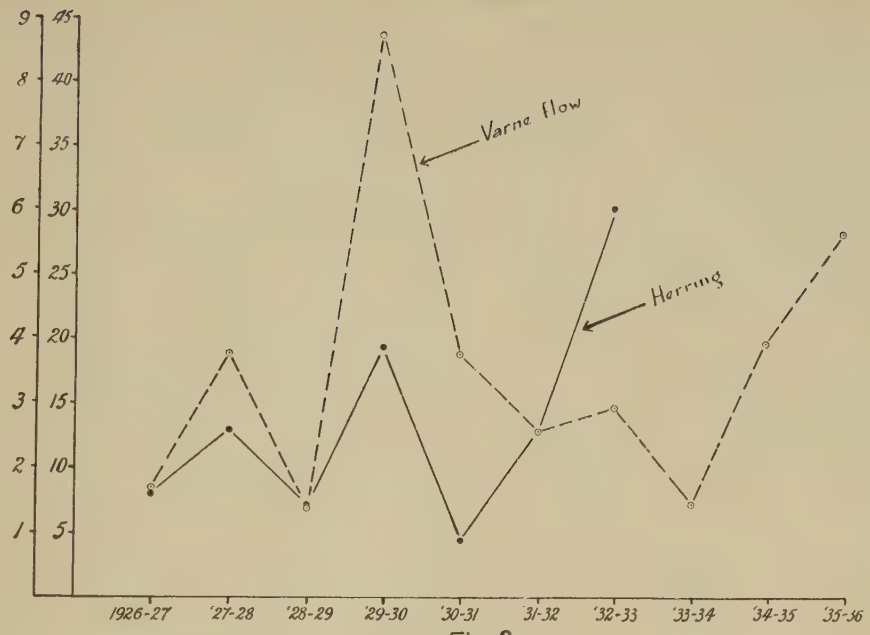


Fig. 2

Herring and Flow of Water past Varne Lightvessel.

[Left-hand Vertical Scale measures water-flow in miles per day averaged for December & January.
Right-hand Vertical Scale measures percentage of 3-year old herring in catches.]

Herrings and Water Movements.

It was then decided to make use of available information upon the flow of water through the Straits of Dover, and from continuous current-meter records preserved in the Lowestoft Laboratory, suitable data for the purpose were prepared. The latter are graphed against percentage abundance of 3-year-old herrings as in the case of water temperature — in Fig. 2.

In that diagram, the data on water-flow are in the form of averages for December and January, and are in effect values which would be obtained if published data on residual currents at the Varne Lightvessel were resolved along the NE.—SW. direction.

In Fig. 2 only seven comparisons are possible, but it is seen that there is for the first five years a similar parallelism to that demonstrated in the case of temperature. Here (in Fig. 2) the parallelism breaks down at 1931/1932 but holds for the following year. The opposite was true for temperature, but if the Varne water-flow data had been plotted (as was temperature) for January alone, the departure from parallelism would be at the same place in both figures.

There is, of course, nothing surprising in the fact that the temperature and water-flow fluctuate together.

It is well to remark that if parallelism between herrings and water-flow fluctuations were established for a fair term of years, there are good reasons why an occasional departure should not be viewed very seriously.

For one thing it is not yet clear in what form it is best to use the Varne current-meter data.

It may well be that survival prospects are better in a year n than in a year $n - 1$ because more water gets into the Southern North Sea from the Channel in the later than in the earlier year, yet, if the flow past the Varne Lightvessel in the year n had very little or no easting in it we might plot for it a value less than that which would apply to the year $n - 1$. This could happen if, as we have good reason to suppose, there are at times conditions of strong flow into the North Sea of which our plotted data (in the form of NE.'ly component) would take insufficient account. A further step seemed called for.

Herrings and Pressure Distributions.

There are certain modifications of the circulation of the waters of the Southern Bight which can take place without our being aware of them from knowledge only of the flow past the Varne Lightvessel. For instance, a month of dominant SE.'ly wind has been known to follow a month of dominantly SW.'ly wind without much modification of the Varne flow — though of course the circulation in the Southern Bight must have been greatly modified.

Because of this, it seemed that a much more comprehensive view of things would be possible if an examination of suitable wind data were made in connection with the present study.

To be adequate, the wind data would have to be prepared for several stations, not only in the Dover Straits area.

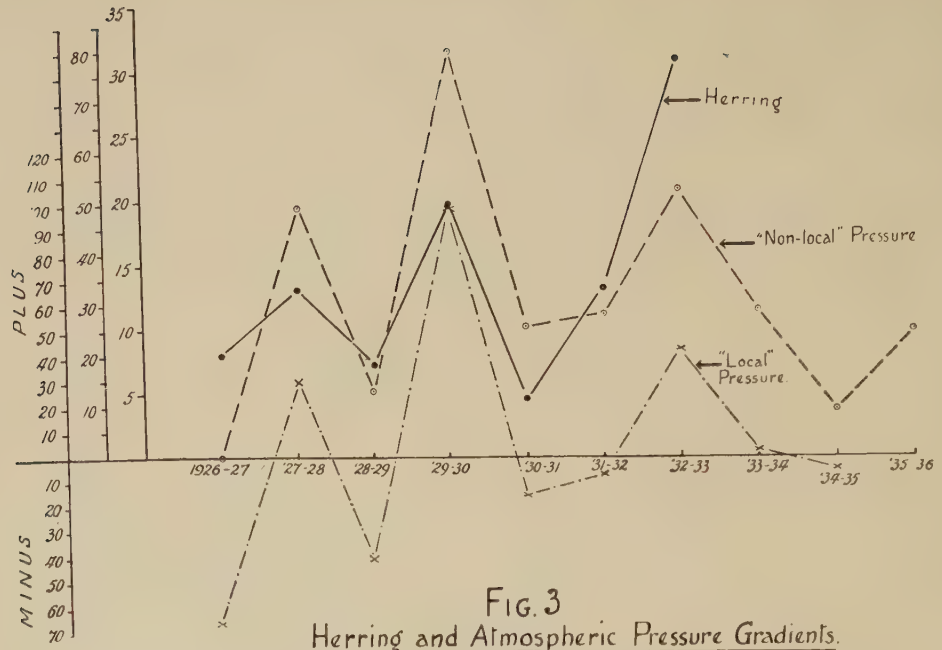


FIG. 3

Herring and Atmospheric Pressure Gradients.

[The Right-hand vertical scale refers to herring as in fig 2; the left-hand one refers to the local pressure data (see "Note One" below) and the middle one to the non-local pressure data (see "Note Two" below)].

Note One. The "local" pressure data plotted were prepared as follows:—
Letting H stand for mean monthly barometric pressure in tenth-millibars at Helder, and Y, B, and K, for the same at Yarmouth, Brussels, and Kew, respectively — and denoting December and January by the suffixes d and j, the quantity plotted was:—

$$(H_{d+j} - Y_{d+j}) + (B_{d+j} - K_{d+j}).$$

Note Two. The "non-local" pressure data employed, involved the average barometric pressure in millibars (to two places of decimals) for December and January at Brest (B), Scilly (S), Helder (H), Yarmouth (Y), Lerwick (L), and Utsire (U). Correction for distance apart was introduced by appropriate division, e. g.:— 132 miles is the distance from Brest to Scilly.
The quantity plotted was:—

$$\frac{B-S}{132} + \frac{H-Y}{114} + \frac{U-L}{194}$$

— after multiplying by 1,000.

Clearly, an appropriate study of barometric pressure gradients was the course to follow. It was decided to choose barometric gradients controlling the run of SW.'ly winds along the English Channel at large, and of S.'ly winds over the North Sea at large — and afterwards to turn to gradients controlling run of wind up the Southern Bight from the Straits of Dover.

For the first step, attention was paid to the gradients:—

Brest — Scilly
Helder — Yarmouth
Utsire — Lerwick

and the requisite pressure data were very kindly supplied by Dr. C. E. P. Brooks of the Meteorological Office. The three gradients were summed after correcting for distance. The results are graphed against the same herring data as before — in Fig. 3.

Then, in the more local study, the gradients: —

Helder — Yarmouth
and
Brussels — Kew

were summed and plotted. In this case use was made of pressure data for Helder kindly supplied by Director P. M. van Riel, and the Kew data were extracted from Meteorological Office publications.

Averages for December and January were employed. Examination of Figure 3 shows that there is a parallelism for all the years embraced when the herring fluctuations are plotted against pressure, and it is intended later to extend the pressure curves back to cover the year-classes 1923, 1924 and 1925.

Discussion.

An obvious feature of Fig. 3 is the absence of roportionality between the two sets of data which xpress the fluctuations compared. This is not to be ondered at but it would be beyond the scope of is paper to go into great detail explaining why. here are good grounds for supposing that such a easure of parallelism as we have demonstrated is l that can be expected from comparisons of the pe made.

In saying this we have the following considerations mind.

Whether or not the water movements within the outhern Bight would be more or less the same in wo different winters because the wind conditions ere similar, depends to some extent upon what we ay for brevity call "Atlantic influences".

It is known that the circulation of the North Sea ndergoes long-enduring modifications due to pulsa- ons in strength on the part of the Atlantic current.

It follows that we have more reason to expect ifferent values for pressure to be associated with ifferent values for herring at yearly than at longer ntervals, and can see why, at an interval of several ears, similar herring values might be associated ith markedly different pressure values.

The Practical Value of the Results.

When the forecasting of the East Anglian herring shery was first started in 1929, it was found that, hile we could give a very good idea of the relative bundance of the year-classes older than three years, was impossible even to guess the strength of the ree-year-old fish which were coming into the shoals r the first time. Consequently, it was necessary to dmit that the forecasts were to some extent incom- lete, but now that this parallelism between three- ear-old fish and "pressure" has been noticed, it hould be possible to say in each future forecast that he incoming year-class will be greater or less than hat which entered the shoals in the previous year.

For example, when this paper was in preparation, e expected that the three-year-old fish which were o appear in the autumn shoals in 1936 would be uch less numerous than they were in 1935, because he "pressure" recorded for the year 1933—1934 was uch less than in 1932—1933 (Fig. 3).

The results of the sampling of the shoals in the last autumn herring fishery have just become available, and it is found that the 1933 year-class (three years old in 1936) only comprised 9·5 % of the total catch, as compared with 30·7 % in the case of the 1932 year-class in the previous year.

As a knowledge of the abundance of these young herrings in the shoals is, from the commercial point of view, very important, it is felt that we shall now be able to fill a gap in the forecasts and thus make them still more complete.

Addendum.

Since writing the above it has occurred to us to examine statistics relating to the landings of spent herrings by the Ostend fleet in the seasons 1927/28 onwards.

The average catches per boat (in units of 100 kg.) were as follows according to records in our possession.

Season	Catch
1927/28	47·3
1928/29	114·9
1929/30	70·2
1930/31	83·7
1931/32	52·2
1932/33	45·9
1933/34	84·6
1934/35	146·2
1935/36	112·2

If these numbers are compared with the pressure values graphed in Fig. 3 above, it is seen that upward changes in pressure are associated with downward changes in the size of the catch — and *vice versa*. This holds for all the nine seasons concerned.

We suggest the following as a tentative explanation.

In seasons when the flow of water in a NE.'ly direction along the Franco-Belgian coast is weak, the spent herrings (which are making a denatant migration) will remain in the area longer than in seasons when the flow is strong.

In making this suggestion, we assume that the spent herrings have come from the spawning concentrations in the Straits of Dover area.

5.

A Note on Plaice Fluctuations in the Southern North Sea.

By

J. N. Carruthers

(Fisheries Laboratory, Lowestoft).

In his paper on the relative strength of different year-classes of plaice in various regions, which appeared in Vol. 101 (3rd Part) of the Rapports et Procès-Verbaux issued in July 1936, Bückmann refers to certain data on the Dover Straits current with which the present writer had supplied him.

This he does at the end of his paper in a very interesting connection — in the consideration of plaice fluctuations in the Dutch and East Friesian area, and in the North Friesian and Horn's Reef area.

It has always been hoped that the information upon flow of water from Channel to North Sea, which has now been collected continuously by the Lowestoft Laboratory for over ten years, would one day prove to be of value in explaining those fluctuations.

Up to now, the only progress made in so using the information in question, is as recorded in a paper which I read before Section D of the British Association at the 1934 Aberdeen Meeting. In that paper (which was printed in summary form as an appendix to my second Varne report), I reached the conclusion that the best prospects existed for the plaice when the current conditions during the spawning season had been most nearly average in character.

Winters characterised by current conditions markedly "un-average" have produced poor year-classes of plaice.

The Aberdeen paper referred to contained the remark that, broadly viewed, good herring survival has been a feature of those years which witnessed good plaice survival.

In view of this, it was decided to examine Bückmann's data on plaice fluctuations (those appropriate in respect of locality) in a similar manner to that adopted by Carruthers and Hodgson when dealing with fluctuations in the herring of the East Anglian Autumn Fishery. Their results are set down in a joint paper which appears as App. No. 4 in this volume, and reference to it will show that a useful parallelism is displayed between the year-to-year variations in abundance of 3-year-old herring in the catches, and the barometric-pressure gradients controlling certain directions of wind throughout the period during which the herring passed the earliest stages of their life. Since use is made in that joint paper of the present writer's Varne current data, a comment on Bückmann's use of them a year ago will not be out of place.

He remarks as follows after comparing the Varne water-flow data (expressed as average values for December and January 1926/27 to 1934/35) with values expressing year-class strengths of plaice assessed for both the Dutch and East Friesian and the North Friesian and Horn's Reef regions:—

"Eine Beziehung ergibt sich ebensowenig zu dem südwestlichen wie zu dem nordöstlichen Teil der Jungschollengebiete."

It does seem, however, that there was a measure of parallelism worth having been mentioned by Bückmann. The descriptions of plaice year-class quality given by him for the Dutch and East Friesian area were as follows — the figures for Varne flow being set down beneath them:—

1927	1928	1929	1930	1931
Rich Over-Average	Very Rich	Poor Sub-Normal	Rich Over-Average	Poor Sub-Normal
42	95	35	220	95
1932	1933	1934	1935	1936
Rich Over-Average	Average or Normal	Average or Normal	?	?
65	75	37	100	142

It happens that the departure from parallelism 1932 can be reasonably "explained away" without uch difficulty on lines of argument developed in he paper by Carruthers and Hodgson App. No. 4 this volume. In the case of the herring also paral- lism broke down at the same place (see their Fig. 2).

It should be mentioned that it is argued in that int paper, that a useful measure of parallelism is ll that it can generally be hoped to demonstrate such comparisons as are here under consideration – there being good reasons why an obvious absence f proportionality should not be regarded very eriously.

Bückmann, in his 1936 and earlier papers, men- ons the results of comparing plaice fluctuations ith resultant winds as worked out for January and ebruary for stations in the Channel, and in the outhern and German Bights.

Over the term of years 1924—1934, he discerned o satisfactory inter-relationship, but he did arrive t a satisfactory one between year-class quality luctuations and wind conditions in February (not January) in the German Bight alone. This outcome or February is of interest in connection with a emark made below. His satisfactory inter-relation- hip involved regarding wind resultants from the irections SW. and W. is of good portent, but he btained a "misfit" in the case of 1929 — which ingle case he reasonably supposed might well be ttributed to the very cold conditions then prevalent.

In the case of the herring a "misfit" did not occur t 1929.

Plaice Fluctuations and Atmospheric Pressure Gradient.

It occurred to the present writer to make a plaice/ ind comparison in a much simpler manner and yet n a more comprehensive scale — by employing tmospheric pressure gradient data as is done in he case of the herring in the joint paper to which eference has several times been made.

If we pay regard to the gradients Brest *minus* cilly and Brussels *minus* Yarmouth added for the months of December and January, we concern urselves with quantities which control the run of ind up the Channel and up the Southern Bight at he appropriate season. We obtain the values here et out in the third column from the left:—

Spawning Season	Plaice Year-Class Quality[1]	Pressure-Gradient Values for Decbr. + January	Pressure-Gradient for Febr.[2]
1926/27 ...	Rich, Over-average	3·2	1·2
1927/28 ...	Very Rich	9·0	2·9
1928/29 ...	Poor, Sub-normal	2·9	0·0
1929/30 ...	Rich, Over-average	18·6	—1·4
1930/31 ...	Poor, Sub-normal	5·9	2·2
1931/32 ...	Rich, Over-average	8·9	—2·3
1932/33 ...	Average or normal	6·7	1·8
1933/34 ...	Average or normal	3·9	0·2
1934/35 ...	?	5·0	3·1
1935/36 ...	?	8·6	1·4
1936/37 ...	?	..	..

[1]) Dutch and East Friesian area as before.
[2]) For Brussels *minus* Yarmouth only — the Brest *minus* Scilly data not being available for this month.

It is seen that there is a good parallelism in that the two things compared fluctuate in the same sense as year follows year.

If it were known that the 1933/34 spawning proved less productive than that of the year before (it did in the case of the herring and presumably the same general description for the two plaice broods does not imply knowledge of precise equality) the parallelism would hold for the whole term of years dealt with, and could, it is supposed, easily be extended to a number of earlier years.

Any prognostications based upon this result would be of the same limited but nevertheless useful type as are now possible for the herring.

We should, for instance, expect the 1934/35 plaice spawning to prove somewhat more productive than was that of 1933/34.

It is to be noted that there is a marked absence of parallelism if we consider the pressure data for February.

It should be added that the above Plaice/Wind investigation was not restricted to the consideration of pressure gradients controlling winds from SW.'ly and NE.'ly points.

Attention was paid also to winds from NW.'ly and SE.'ly points, but without result.

6.

Continuous Current Observations for Fishery Research Application.

By

J. N. Carruthers

(Fisheries Laboratory, Lowestoft).

A year ago, a short paper entitled "Continuous Current Measuring in the Southern Bight" was published by the present writer in Volume C of this series. That brief paper had a very definite object — to support the plea that programmes of non-stop current measuring should be undertaken from as many lightvessels as possible in the southern North Sea, and in it the opinion was expressed that such work is essential if ever a proper study of the connection between currents and certain fish fluctuations is to become possible.

Since that time it has become possible (1) to advance ample proof that continuous observations of the type suggested are quite easy to keep in train, (2) to give more definite information as to the initial outlay involved, (3) to show that running expenses, apart from the question of rewards paid to observers, are almost negligible, and (4) to present realistic illustrations showing what the apparatus used by the Lowestoft Laboratory looks like when rigged for use on shipboard.

In my last years' paper, I gave references to publications describing the instrument concerned — the "Vertical Log" — and mentioned that it had been in use from the lightvessels Smiths Knoll, Galloper, and Sandettié. It was used from the two last-named vessels in connection with a 12-weeks' townetting campaign which it is expected to repeat each winter. As the result of that work, something is known of the quantity of fish eggs and larvae which passed those two observing points, and it is known towards what direction they would be transported. This knowledge may prove useful in the consideration of plaice and herring fluctuations; at any rate it would seem to be the right sort of information to collect for that purpose.

A year ago it was possible to present only part of the current data obtained, and, since the results covering the full period were later exhibited when the instrument was demonstrated on the Council's premises last May, it has been considered advisable to put them on record in print. This will permit support to be drawn from them for statements made below.

This last winter (1936/37) the 12-weeks' plankton collecting campaign was repeated, and in connection with it the "Vertical Log" was again kept in continuous use aboard the Galloper and Sandettié lightships. The bad weather experienced did not interfere with the work in the least and the instruments sustained no damage whatsoever. The only time-breaks were negligible and were caused by service exigencies — reliefs etc. For the opportunity to observe again from the Sandettié lightvessel, acknowledgement is made of further kind co-operation on the part of the French "Office Scientifique et Technique des Pêches Maritimes".

In the case of the continuous current observations from the Galloper and Sandettié lightships during winter 1936/37, only a bare summary of the results obtained is given below. This summary is presented not only to serve arguments to be put forward, but to emphasize in company with the more extensive proof provided by the citation of other and longer series of observations, that the type of work pressed for is quite definitely easy to carry out.

Since July 1936 a Vertical Log has been in continuous use from the Royal Sovereign lightvessel and the very wild weather of November was unable to interrupt the work at all — in fact no time has been lost since the installation.

Similar observations which have been going on

om the Cromer Knoll lightship since August 1936 ave been equally free from interruption and trouble. he actual observing is now easier than it was at rst, because a new type of direction-viewing unit ee illustration) now employed gets rid of certain inor difficulties which used to arise round about he time of slack water, and occasionally when, uring a weather-tide, the ship was not riding head o stream. This new accessory (which, by the way, "homemade") makes it possible to carry out bservations much below the surface. Recently from he lightvessel sub-surface observations were made ynchronously with measurements at the depth of bout 9 fathoms for over a fortnight. It is necessary o mention also another new accessory which has een taken into use since the instrument was demonrated in Copenhagen. It is a very simple and cheap ne. Nowadays a master-counter is made use of; his is fitted in the spindle box and serves to record ll the revolutions made irrespective of direction. can be re-set to zero on turning a knurled knob, nd by using it it has become possible to correct any isreading of one of the individual counters. Such areless misreadings have been noticed perhaps once r twice a month, and, although it has usually been ossible to detect and correct them without much ifficulty, such errors can now be remedied very mply indeed if the master-counter is re-set to zero ach day at the start of a new observation.

A comment is called for here regarding the expreson "new observation". The routine continuous bservations as carried out for the Lowestoft Laboatory call for the counters to be read once every ay, and in that sense the work does consist of daily bservations. Since there is usually not a minute lost, he daily readings can be ignored if so desired and result for a whole month obtained without reference o them.

This is an important point, because for fishery esearch purposes monthly averages will often be all hat is required. If so, it is possible to multiply bserving points and also reduce the bulk of papers hich have to be filed.

Such monthly averages are of course obtained by imply subtracting the eight counter readings for he first day of the month from those recorded on he last day. Simple printed forms are available to ake this work extremely easy. Whilst speaking of he master-counter (shown in an illustration below) ttention should be drawn to another use which can e made of it. An instrument fitted with it can serve wo purposes at the same time. In addition to the rdinary routine use which involves in effect distribting the revolutions made amongst eight equal ivisions of the compass, readings of the masterounter can be made at chosen time intervals and he precise direction of the stream noted. Obserations of the latter type would of course have a ore direct navigational bearing, and would probably e of special value because (1) they would not need o stop for stress of weather, and (2) they would refer to the movements of a column of water representative of the draught of a ship.

With one further comment we can proceed to set down the results which were exhibited when the instrument was demonstrated. The comment is this: —

Because of the rope link between cups and counter, and because of the fact that the direction of stream-flow is actually viewed, it results that the indications of the instrument are no less acceptable during wild weather than in calm. This is seen to be an important point if consideration be devoted to what would be the behaviour of certain self-contained current-meters fitted with cups or propellers. If such instruments were robust enough to be used during wild weather, the lively movements of the observing ship would hardly fail to result in the addition of many revolutions which would have nothing to do with stream-flow. Also, one could reasonably expect that such adventitious revolutions would be associated with much "spread" in the direction registration.

Observations in Winter 1935/1936.

Below are the results of the continuous current observations made during winter 1935/1936 at the Galloper and Sandettié lightvessels — all of which were exhibited when the instrument was demonstrated, but of which less than half were published last year.

They have now been summarized for separate months and a table of wind data[1]) is presented with them. In the last paper only sketchy marginal notes on wind conditions were appended.

It is not intended to add details of contemporaneous observations carried out at the Varne and Cromer Knoll lightvessels, although these are available and were used in drawing up the chart of currents exhibited last May.

At those two lightships the Drift Indicator was in continuous use, and since that instrument is used at the depth of 6 fathoms the observations made with it are not strictly comparable with those just presented.

It is very necessary to point out that the above tabulations of data may not be accepted just as they stand, for it has been discovered that the wrong conversion factor was inadvertently used in preparing them.

To obtain correct values all the figures in Tables 1 and 2 denoting water movements, should be reduced by one-tenth.

It has not been considered worth the labour to draw up new tables embodying the correction, as the latter can be easily applied to such results as it may be wished to use, and moreover, the tables as they stand are just as they were exhibited. Also, the feature of chief interest — the marked changes in speed and direction, would be unaffected if the figures were all reduced by one-tenth.

[1]) Also exhibited at the time of the demonstration.

Table 1.

Results of Continuous Observations with the "Vertical Log" Current-Meter aboard the Galloper Lightvessel (51°44′ N.—1°58′ E.) during Winter 1935/36.

Ref. No. of Record	Lunar Day Centred on:—		Sea-Miles of Water-Movement towards the Octant Centred on:—								Sea-Miles of Water-Movement towards all Directions. Also Phase etc. of the Moon[1])		Residual Current = Vector Sum of the eight "Octant Entries" (Sea-Miles per Lunar Day towards a true Direction)[2])	
			N.	NE.	E.	SE.	S.	SW.	W.	NW.				
1	2145	on 1.12.35	7·60	2·97	..	..	..	4·42	7·94	2·69	25·63		13·8	N. 62° W.
2	2235	- 2.12.35	3·82	6·55	..	..	..	6·40	2·32	5·38	24·47		9·8	N. 48° W.
3	2325	- 3.12.35	2·20	8·93	..	..	..	11·11	0·60	0·65	23·49	F. Q.	2·8	N. 77° W.
4	0015	- 5.12.35	1·16	10·91	0·08	..	0·64	9·31	0·11	0·84	23·05	P.	2·3	N. 3° E.
5	0105	- 6.12.35	1·06	11·78	..	..	0·02	10·62	1·35	..	24·83		1·9	N. 26° W.
6	0155	- 7.12.35	2·94	9·59	..	..	0·15	11·76	0·55	..	25·00		2·4	N. 69° W.
7	0245	- 8.12.35	0·26	12·77	0·62	..	..	14·68	..	..	28·33		1·3	S. 24° W.
8	0335	- 9.12.35	0·40	14·37	0·71	..	..	13·44	1·13	..	30·04		1·1	N. 3° E.
9	0425	- 10.12.35	0·18	20·56	..	..	..	8·46	..	..	29·20	F. M.	12·2	N. 34° E.
10	0515	- 11.12.35	..	20·42	..	..	..	11·34	0·26	..	32·02		8·9	N. 34° E.
11	0605	- 12.12.35	0·11	15·80	0·55	..	0·13	16·00	0·32	..	32·91		0·3	S. 29° E.
12	0655	- 13.12.35	8·76	6·03	0·81	..	0·77	14·90	..	..	31·28		5·7	N. 82° W.
13	0745	- 14.12.35	..	15·18	0·34	..	..	14·87	0·30	..	30·69		0·3	N. 40° E.
14	0835	- 15.12.35	..	11·44	..	0·03	..	15·12	1·00	..	27·60		4·4	S. 44° W.
15	0925	- 16.12.35	..	7·02	..	..	0·45	9·55	1·03	0·53	18·59		3·7	S. 50° W.
16	1015	- 17.12.35	0·20	11·20	..	..	..	6·23	3·00	0·05	20·68	L Q.	3·8	N. 3° W.
17	1105	- 18.12.35	0·32	6·18	..	..	..	9·03	0·43	..	15·96	A.	3·0	S. 45° W.
18	1155	- 19.12.35	..	8·17	5·13	..	..	3·61	..	0·14	17·05		8·9	N. 58° E.
19	1245	- 20.12.35	..	4·33	5·26	..	..	1·10	7·08	..	17·76		2·3	N. 1° E.
20	1335	- 21.12.35	4·89	5·96	..	..	..	7·76	0·31	..	18·91		4·0	N. 34° W.
21	1425	- 22.12.35	3·07	5·07	..	..	..	8·22	4·65	..	21·01		6·9	S. 87° W.
22	1515	- 23.12.35	6·00	8·53	..	..	..	7·09	..	..	21·63		7·1	N. 2° W.
			See Below — Note "One".									N. M.		
23	1745	- 26.12.35	..	9·13	..	..	..	32·39	..	..	41·52		23·2	S. 35° W.
24	1835	- 27.12.35	..	13·64	..	..	..	20·33	..	..	33·97		6·7	S. 35° W.
25	1925	- 28.12.35	..	16·80	..	..	..	15·23	..	..	32·03		1·6	N. 35° E.
26	2015	- 29.12.35	0·15	13·38	..	..	..	19·74	..	..	33·27		6·3	S. 36° W.
27	2105	- 30.12.35	0·81	8·00	0·74	..	..	19·87	..	..	29·42	P.	10·8	S. 35° W.
28	2155	- 31.12.35	..	14·19	..	..	..	17·13	..	..	31·32		2·9	S. 35° W.
Dec. 1935			1·57	10·67	0·51	0·00	0·08	12·13	1·16	0·37	26·49		2·1 = towards Clacton	N. 80° W.
29	2245	on 1.1.36	..	11·51	..	..	..	16·39	..	..	27·90	F. Q.	4·9	S. 35° W.
30	2335	- 2.1.36	..	7·27	..	..	..	12·07	..	..	19·34		4·8	S. 35° W.
31	0025	- 4.1.36	..	16·02	..	..	..	11·02	..	..	27·04		5·0	N. 35° E.
32	0115	- 5.1.36	..	12·60	..	..	..	10·59	..	..	23·19		2·0	N. 35° E.
33	0205	- 6.1.36	..	9·77	..	..	..	16·60	..	..	26·37		6·8	S. 35° W.
34	0255	- 7.1.36	..	9·23	..	..	..	18·13	..	..	27·36		8·9	S. 35° W.
35	0345	- 8.1.36	..	12·81	..	..	..	17·39	..	..	30·20	F. M.	4·6	S. 35° W.
36	0435	- 9.1.36	..	11·09	..	..	..	19·56	..	..	30·65		8·5	S. 35° W.
37	0525	- 10.1.36	..	10·17	..	..	..	18·41	..	..	28·57		8·2	S. 35° W.
38	0615	- 11.1.36	..	16·76	..	..	..	14·42	..	..	31·19		2·3	N. 35° E.
39	0705	- 12.1.36	..	19·61	..	..	..	11·57	..	..	31·19		8·0	N. 35° E.
40	0755	- 13.1.36	..	14·94	..	..	..	13·15	..	..	28·09		1·8	N. 35° E.
41	0845	- 14.1.36	..	16·76	..	..	..	10·33	..	..	27·09	A.	6·4	N. 35° E.
42	0935	- 15.1.36	..	12·87	..	..	..	12·00	..	..	24·87		0·9	N. 35° E.
43	1025	- 16.1.36	0·24	10·04	..	..	..	11·85	..	..	22·13	L. Q.	1·7	S. 41° W.
44	1115	- 17.1.36	..	12·17	..	..	..	6·50	..	..	18·67		5·7	N. 35° E.
45	1205	- 18.1.36	..	3·77	..	..	..	7·54	..	..	11·31		3·8	S. 35° W.

Table 1 (continued).

Record	Lunar Day Centred on:—	Sea-Miles of Water-Movement towards the Octant Centred on:— N.	NE.	E.	SE.	S.	SW.	W.	NW.	Sea-Miles of Water-Movement towards all Directions. Also Phase etc. of the Moon[1])		Residual Current = Vector Sum of the eight "Octant Entries" (Sea-Miles per Lunar Day towards a true Direction)[2])
			See Below — Note "Two".									
			See Below — Note "Three".									
	2115 on 20.1.36	..	12·79	..	..	..	7·12	..	..	19·91		5·7 N. 35° E.
	2205 - 21.1.36	..	10·59	0·71	..	..	11·44	..	..	22·73		0·6 S. 20° E.
	2255 - 22.1.36	..	11·49	0·25	0·24	..	13·09	..	..	25·06		1·5 S. 19° W.
	2345 - 23.1.36	0·24	15·06	..	..	0·36	13·86	0·39	..	29·91	N. M.	0·9 N. 22° E.
	0035 - 25.1.36	0·05	13·67	..	0·75	1·79	16·56	..	..	32·81		4·6 S. 9° W.
	0125 - 26.1.36	..	16·06	1·14	..	0·31	17·87	0·11	..	35·50	P.	1·6 S. 1° E.
	0215 - 27.1.36	0·19	15·58	..	0·86	0·31	18·53	..	..	35·47		3·2 S. 18° W.
	0305 - 28.1.36	..	13·68	..	0·77	0·86	15·08	0·30	..	30·68		2·5 S. 7° W.
	0355 - 29.1.36	..	13·19	..	0·16	1·78	17·69	0·18	..	33·00		6·0 S. 23° W.
	0445 - 30.1.36	..	13·08	0·38	..	..	16·60	2·26	..	32·32	F. Q.	5·0 S. 50° W.
	0535 - 31.1.36	..	10·70	..	0·28	0·94	14·45	0·33	..	26·70		4·7 S. 26° W.
n. 36		0·03	12·62	0·09	0·11	0·23	13·92	0·13	0·00	27·12		1·5 S. 26° W. = towards Dover Straits
	0625 on 1.2.36	..	8·99	0·14	..	0·85	12·41	..	..	22·39		4·0 S. 25° W.
	0715 - 2.2.36	..	9·31	..	..	0·05	8·18	1·11	..	18·65		0·8 N. 32° W.
	0805 - 3.2.36	..	12·86	..	..	..	6·79	0·97	..	20·62		5·4 N. 28° E.
	0855 - 4.2.36	..	13·04	..	..	0·44	8·01	..	..	21·49		4·7 N. 39° E.
	0945 - 5.2.36	..	7·17	..	0·50	0·24	16·24	..	..	24·14		9·3 S. 31° W.
			See Below — Note "Four".									
	0425 - 7.2.36	..	12·85	..	1·46	0·24	13·59	1·00	..	29·14	F. M.	1·9 S. 5° W.
	0515 - 8.2.36	..	12·01	..	0·06	0·89	16·93	..	..	29·89		5·6 S. 28° W.
	0605 - 9.2.36	..	15·71	..	0·39	..	17·00	0·22	..	33·33		1·5 S. 25° W.
	0655 - 10.2.36	..	15·44	..	0·66	0·17	10·91	0·52	..	27·70		4·1 N. 41° E.
	0745 - 11.2.36	..	8·04	..	0·96	..	19·43	1·09	..	29·52	A.	12·2 S. 34° W.
	0835 - 12.2.36	..	14·42	0·51	0·54	..	13·04	0·43	..	28·93		1·6 N. 57° E.
	0925 - 13.2.36	..	12·00	..	0·20	3·18	12·02	..	..	27·39		3·3 S. 12° E.
	1015 - 14.2.36	..	11·90	..	0·79	0·07	11·98	0·11	..	24·86		0·8 S. 39° E.
	1105 - 15.2.36	..	11·81	..	0·47	0·40	12·56	0·28	..	25·52	L. Q.	1·4 S. 11° W.
	1155 - 16.2.36	..	11·38	..	0·19	0·61	7·04	0·16	..	19·37		3·8 N. 43° E.
	1245 - 17.2.36	..	4·48	..	0·21	0·16	10·04	0·20	..	15·09		5·8 S. 33° W.
	1335 - 18.2.36	..	5·27	..	..	0·74	11·69	0·04	..	17·75		7·0 S. 31° W.
	1425 - 19.2.36	..	12·47	..	..	..	6·90	0·28	..	19·65		5·4 N. 33° E.
	1515 - 20.2.36	..	11·19	..	0·31	..	13·36	0·30	..	25·16		2·4 S. 33° W.
	1605 - 21.2.36	..	26·24	..	0·31	0·23	15·14	0·30	..	42·22		10·8 N. 36° E.
	- 22.2.36	..	..	..	..	..	..	..	..		N. M.	..
	- 23.2.36	..	..	..	..	..	..	..	..		P.	..
b. 36	L. Days	0·00	11·83	0·03	0·35	0·41	12·16	0·35	0·00	25·14		0·9 S. 9° W. = towards Calais
	Winter 1935/36 Dec. 35 Jan. 36 Feb. 36	0·53	11·71	0·21	0·15	0·24	12·74	0·55	0·12	26·25		1·2 S. 56° W. = towards Whitstable

Notes: "One" — Here a counter functioned badly and was replaced. "Two" — Here the instrument was unrigged during the Relief. "Three" - Here an un-oiled counter seized up. "Four" — Here the lightship's cable was changed.

[1]) In this column, "F. M." & "N. M." stand for Full & New Moon respectively; A = Apogee & P = Perigee.

[2]) Note that all water-movements within the various octants have been arbitrarily referred to the middle directions.

Table 2.

Results of Continuous Observations with the "Vertical Log" Current-Meter aboard the Sandettié Lightvessel (51°13′ N.—1°54′ E.) during Winter 1935/36.

A — December 1935.

Ref. No. of Record	Lunar Day Centred on:—	Sea-Miles of Water-Movement towards the Octant Centred on:— N.	NE.	E.	SE.	S.	SW.	W.	NW.	Sea-Miles of Water-Movement towards all Directions. Also Phase etc. of the Moon[1])	Residual Current = Vector Sum of the eight "Octant Entries" (Sea-Miles per Lunar Day towards a true Direction)[2])
1	1925 on 1.12.35	..	12·95	..	0·20	14·64	0·04	..	..	27·84	10·8 S. 69° E.
2	2015 - 2.12.35	..	11·10	..	5·99	9·84	..	..	..	26·93	13·6 S. 73° E.
3	2105 - 3.12.35	..	11·46	..	..	14·56	..	..	..	26·02 F. Q.	10·4 S. 61° E.
4	2155 - 4.12.35	0·10	9·50	0·07	..	14·36	..	..	..	24·03	10·1 S. 52° E.
5	2245 - 5.12.35	..	10·66	..	..	9·26	6·30	..	..	26·21 P.	6·9 S. 36° E.
6	2335 - 6.12.35	..	13·35	..	..	12·31	..	..	..	25·66	9·9 S. 83° E.
7	0025 - 8.12.35	..	16·31	..	..	13·09	..	..	..	29·40	11·6 N. 88° E.
8	0115 - 9.12.35	..	14·52	..	..	9·91	7·60	..	..	32·03	7·0 S. 54° E.
9	0205 - 10.12.35	..	8·89	..	..	21·82	..	..	..	30·70 F. M.	16·8 S. 32° E.
10	0255 - 11.12.35	..	10·24	..	..	23·09	..	..	..	33·33	17·5 S. 35° E.
11	0345 - 12.12.35	..	17·06	..	..	17·32	..	..	..	34·38	13·1 S. 77° E.
		See Below — Note "One".									
12	0110 - 14.12.35	..	19·69	0·12	..	..	11·51	0·27	..	31·59	8·1 N. 34° E.
13	0200 - 15.12.35	0·07	22·21	..	..	..	9·86	..	..	32·14	12·5 N. 35° E.
14	0250 - 16.12.35	..	19·35	0·36	..	1·07	6·73	..	..	27·51	12·1 N. 40° E.
15	0340 - 17.12.35	..	9·95	0·06	0·10	2·99	9·16	..	..	22·26 L Q.	2·6 S. 25° E.
16	0430 - 18.12.35	..	6·42	..	0·22	3·85	8·28	..	..	18·77 A.	5·5 S. 2° W.
17	0520 - 19.12.35	0·41	7·47	..	..	5·06	1·16	0·68	0·17	14·95	3·7 N. 81° E.
18	0610 - 20.12.35	..	5·14	1·36	..	0·21	9·69	..	..	16·40	3·9 S. 19° W.
19	0700 - 21.12.35	..	7·07	0·56	..	4·82	5·69	..	..	18·14	4·1 S. 32° E.
20	0750 - 22.12.35	..	10·04	..	..	..	15·63	..	..	25·67	5·6 S. 35° W.
21	0840 - 23.12.35	..	10·24	..	..	0·06	14·99	..	..	25·28	4·8 S. 34° W.
22	0930 - 24.12.35	4·01	11·14	0·09	..	..	11·77	..	..	27·01	3·6 N. 19° W.
23	1020 - 25.12.35	..	21·17	..	..	..	10·55	..	..	31·72 N. M.	10·6 N. 35° E.
24	1110 - 26.12.35	..	21·26	..	..	8·34	5·64	..	..	35·24	11·4 N. 66° E.
25	1200 - 27.12.35	..	22·13	..	..	10·77	..	..	..	32·89	16·3 N. 63° E.
26	1250 - 28.12.35	..	18·78	..	..	6·95	10·36	..	..	36·09	6·0 Due E.
27	1340 - 29.12.35	..	16·42	..	..	..	13·97	..	..	30·39	2·5 N. 35° E.
28	1430 - 30.12.35	..	21·95	..	..	..	11·10	..	..	33·06 P.	10·9 N. 35° E.
29	1520 - 31.12.35	..	18·41	..	..	..	13·07	..	..	31·49	5·3 N. 35° E.
Dec. 1935		0·12	14·00	0·09	0·22	7·05	6·31	0·03	0·01	27·83	5·9 S. 84° E. = towards Nieuport.

Notes Concerning the above Sandettié Table for December 1935.

"One". This break was due to the fact that the instrument was unrigged by the Crew for the Relief.

[1]) In this column the Moon's phases are indicated as follows:— "F. M." stands for Full Moon, "N. M." for New Moon, "F. Q" for First Quarter, and "L. Q" for Last Quarter. A & P stand for Apogee and Perigee respectively.

[2]) It is to be noted concerning this resultant, that all water-movements within the various octants have been arbitrarily referred to the middle directions.

Discussion.

There is much in Tables 1 and 2 which would repay study by anyone interested in currents *qua* currents, particularly if attention were paid at the same time to the table of wind data. The fact that the water movements can change so much from day to day in both magnitude and direction at the depth of about $1^1/_2$ fathoms, has an important meaning to the worker whose task it may be to study the travels of surface drift-bottles in the Southern Bight.

Attention may here be drawn to a point of considerable interest which also bears on the last remark. In all three months the residual current at the Sandettié flowed towards the opposite quadrant from that towards which the Galloper current headed. As we go from December to January and then to February, the Sandettié current inclined progressively against the clock and decreased in strength. The same remarks apply to the Galloper current.

From data presented in very brief fashion below,

Table 2 (continued).

Record	Lunar Day Centred on:—	Sea-Miles of Water-Movement towards the Octant Centred on:— N.	NE.	E.	SE.	S.	SW.	W.	NW.	Sea-Miles of Water-Movement towards all Directions. Also Phase etc. of the Moon[1])	Residual Current = Vector Sum of the eight "Octant Entries" (Sea-Miles per Lunar Day towards a true Direction)[2])
	B — January 1936.										
0	1610 on 1.1.36	..	16·60	..	..	..	10·10	..	..	26·71 F. Q.	6·5 N. 35° E.
1	1700 - 2.1.36	..	13·63	..	..	..	11·72	..	..	25·35	1·9 N. 35° E.
	See Below — Note "Two".										
2	1840 - 4.1.36	3·94	4·91	..	..	..	13·70	..	..	22·56	6·6 S. 60° W.
3	1930 - 5.1.36	..	17·03	..	..	..	5·86	..	..	22·89	11·2 N. 35° E.
4	2020 - 6.1.36	..	19·77	..	..	..	7·11	..	..	26·89	12·7 N. 35° E.
5	2110 - 7.1.36	..	20·23	..	..	..	10·97	..	..	31·20	9·3 N. 35° E.
6	2200 - 8.1.36	..	18·86	..	..	..	10·34	..	..	29·21 F. M.	8·5 N. 35° E.
7	2250 - 9.1.36	..	22·17	..	..	..	6·53	..	..	28·70	15·6 N. 35° E.
8	2340 - 10.1.36	..	19·39	..	..	6·13	9·45	..	..	34·97	7·1 N. 73° E.
9	0030 - 12.1.36	..	10·63	..	..	..	22·53	..	..	33·16	11·9 S. 35° W.
0	0120 - 13.1.36	..	14·60	..	..	..	14·01	..	0·02	28·63	0·6 N. 35° E.
1	0210 - 14.1.36	..	10·07	..	..	..	22·19	..	..	32·26 A.	12·1 S. 35° W.
2	0300 - 15.1.36	..	9·80	..	..	..	17·61	..	..	27·41	7·8 S. 35° W.
3	0350 - 16.1.36	..	14·01	..	..	..	11·38	..	..	25·39 L. Q.	2·6 N. 35° E.
4	0440 - 17.1.36	..	5·72	..	..	..	14·77	..	..	20·49	9·1 S. 35° W.
5	0530 - 18.1.36	..	9·16	0·19	0·07	0·65	4·14	..	..	14·21	4·8 N. 43° E.
6	0620 - 19.1.36	0·01	6·50	..	..	..	5·04	0·04	..	11·59	1·4 N. 34° E.
7	0710 - 20.1.36	..	13·79	..	..	..	1·46	..	..	15·24	12·3 N. 35° E.
8	0800 - 21.1.36	..	20·46	1·83	..	..	1·85	..	..	24·14	19·9 N. 39° E.
9	0850 - 22.1.36	..	13·74	0·06	..	..	11·21	..	..	25·00	2·6 N. 36° E.
0	0940 - 23.1.36	..	15·39	0·12	..	..	15·09	..	..	30·60	0·4 N. 47° E.
1	1030 - 24.1.36	..	17·11	..	..	..	16·67	..	..	33·78 N. M.	0·4 N. 35° E.
2	1120 - 25.1.36	..	19·24	..	..	..	17·19	..	..	36·43	2·1 N. 35° E.
3	1210 - 26.1.36	..	15·36	..	..	..	14·77	..	..	30·12 P.	0·6 N. 35° E.
4	1300 - 27.1.36	..	18·14	..	..	..	12·63	..	..	30·77	5·5 N. 35° E.
5	1350 - 28.1.36	..	17·21	..	..	..	14·27	..	..	31·49	2·9 N. 35° E.
6	1440 - 29.1.36	..	16·23	..	..	..	12·25	..	..	28·49	4·0 N. 35° E.
7	1530 - 30.1.36	..	12·79	..	..	..	10·48	..	..	23·26 F. Q.	2·3 N. 35° E.
8	1620 - 31.1.36	..	19·73	..	..	..	8·01	..	..	27·74	11·7 N. 35° E.
an. 936		0·14	14·91	0·08	0·00	0·23	11·49	0·00	0·00	26·85	3·4 N. 37° E. = towards Ringkiobing.

Notes Concerning the above Sandettié Table for January 1936.

"Two". Here, one of the counters stopped working and was not replaced soon enough for the record to be acceptable.
The remarks made under the table for December 1935 against [1]) and [2]) apply here also.

t will be seen that during the three same months of inter 1936/37 there was a similar state of affairs — he two currents again displaying comparable changes n strength and like changes in direction from month o month. These facts would be understandable if the wo lightships were on opposite sides of the axis of n eddy or tongue trending roughly SW. to NE., and usceptible of some variation in orientation. In this onnection we may recall that our published records rom the Varne lightvessel show that the average set or six winters was directed towards N. 36° E. true. his direction is visualized if a line be imagined drawn rom the Varne to the East Goodwin lightvessel, and his line if continued, would pass between the positions of the Sandettié and Galloper lightvessels. If the scope of this paper permitted, it would be of great interest to discuss here certain findings of Kurt Kalle in his elaborate paper "Nährstoff-Untersuchungen als hydrographisches Hilfsmittel zur Unterscheidung von Wasserkörpern" which appeared in the Annalen[1]) of January, 1937.

Suffice it to point to the facts (see his Abb. 2) that he inferred the existence of a current directed towards the SW. quadrant in the neighbourhood of the

[1]) Annalen der Hydrographie und Maritimen Meteorologie.

Table 2 (continued).

Ref. No. of Record	Lunar Day Centred on:—	Sea-Miles of Water-Movement towards the Octant Centred on:— N.	NE.	E.	SE.	S.	SW.	W.	NW.	Sea-Miles of Water-Movement towards all Directions. Also Phase etc. of the Moon[1])		Residual Current = Vector Sum of the eight "Octant Entries" (Sea-Miles per Lunar Day towards a true Direction)[2])	
					C — February 1936.								
59	1710 on 1.2.36	..	2·40	..	..	..	4·15	..	..	6·55		1·8	S. 35° W.
60	1800 - 2.2.36	..	5·53	..	..	..	9·87	..	..	15·40		4·3	S. 35° W.
61	1850 - 3.2.36	..	3·21	..	..	3·56	5·65	..	..	12·42		5·6	S. 8° W.
62	1940 - 4.2.36	..	7·46	..	..	..	11·31	..	..	18·77		3·9	S. 35° W.
63	2030 - 5.2.36	..	11·69	..	..	..	11·64	..	..	23·33		0·1	N. 35° E.
64	2120 - 6.2.36	..	13·01	..	..	..	11·95	..	..	24·97		1·1	N. 35° E.
65	2210 - 7.2.36	..	12·85	..	..	..	14·34	..	..	27·19	F. M.	1·5	S. 35° W.
66	2300 - 8.2.36	..	10·88	..	..	..	14·88	..	..	25·76		4·0	S. 35° W.
67	2350 - 9.2.36	..	12·04	..	..	..	14·76	..	..	26·80		2·7	S. 35° W.
68	0040 - 11.2.36	..	11·56	..	..	..	8·81	..	..	20·37	A.	2·8	N. 35° E.
69	0130 - 12.2.36	..	14·81	0·26	..	..	8·46	..	..	23·54		6·5	N. 37° E.
70	0220 - 13.2.36	..	12·88	..	..	..	12·83	..	..	25·71		0·1	N. 35° E.
71	0310 - 14.2.36	..	13·64	..	..	..	10·84	0·03	..	24·51		2·8	N. 55° W.
72	0400 - 15.2.36	..	13·45	..	..	..	6·64	..	..	20·09	L. Q	6·8	N. 35° E.
73	0450 - 16.2.36	..	7·65	..	..	..	7·34	..	..	14·99		0·3	N. 35° E.
74	0540 - 17.2.36	..	6·56	..	..	..	3·21	..	..	9·77		3·4	N. 35° E.
75	0630 - 18.2.36	5·13	7·59	..	..	0·10	0·02	..	..	12·84		11·6	N. 17° E.
76	0720 - 19.2.36	..	16·24	..	..	..	1·84	..	..	18·08		14·4	N. 35° E.
77	0810 - 20.2.36	..	13·80	..	..	..	9·71	..	..	23·50		4·1	N. 35° E.
78	0900 - 21.2.36	4·46	11·98	..	..	..	10·88	..	..	27·31		5·3	N. 2° W.
79	0950 - 22.2.36	..	17·23	..	..	..	14·33	..	..	31.57	N. M.	2·9	N. 35° E.
80	1040 - 23.2.36	..	17·42	..	..	..	15·29	..	..	32·71	P.	2·1	N. 35° E.
81	1130 - 24.2.36	..	17·13	..	..	..	16·84	..	..	33·97		0·3	N. 35° E.
82	1220 - 25.2.36	..	16·09	..	..	..	17·73	..	..	33·82		1·6	S. 35° W.
			See Below — Note "Three".										
83	1400 - 27.2.36	..	18·46	..	..	..	15·14	..	..	33·60		3·3	N. 35° E.
84	1450 - 28.2.36	..	16·13	..	..	..	14·34	..	..	30·47		1·8	N. 35° E.
85	1540 - 29.2.36	..	13·30	..	..	..	12·53	..	..	25·83	F. Q.	0·8	N. 35° E.
Feb. 1936		0·36	12·04	0·01	0·00	0·14	10·57	0·00	0·00	23·11		1·6	N. 30° E. = towards the Skagerrak.
Winter 1935/36 = Dec. 35 + Jan. 36 + Feb. 36		0·21	13·67	0·06	0·08	2·53	9·43	0·01	0·00	26·00		3·2	N. 69° E. = towards Schouwen.

Notes Concerning the above Sandettié Table for February 1936.

"Three". Here, the observations were interrupted by the Relief, and although only one hour was lost, the record is rejected. The remarks made under December against [1]) and [2]) apply here also.

Galloper lightvessel in January, 1935, and that he marks a tongue projecting NE.'wards from the Downs. We could explain our results in other ways than by invoking an eddy or a tongue with more or less oppositely directed currents along its two sides — but perhaps less simply. Whatever eddies may exist in the Southern Bight, it would appear unlikely that they would be discovered from the analysis of drift-bottle data on lines developed by Tait in the case of the northern North Sea.

In saying this we have in mind the quick changes in speed and direction exhibited by the water-flow past the Galloper and Sandettié lightvessels even at the depth of about $1^1/_2$ fathoms, and suppose that the water movements entering into the make-up of the eddies would undergo similar changes.

Further remarks of a purely hydrographical nature would be beyond the scope of this article, and at this point attention may be invited to two papers which appear elsewhere in this volume. One of these by

Table 3.

Record of Wind Conditions aboard the Varne Lightvessel during Winter 1935/36, arranged to suit the continuous "Vertical Log" observations made at the Sandettié lightship only 29 miles away.

The basic wind data were estimates made eight times daily according to the Beaufort Scale. To each "Vertical Log" record, nine wind observations were allotted. For compactness, the Beaufort numbers were converted into m. p. h. and summed for each direction concerned. Each entry denotes therefore, the total "miles of wind" from the direction in question.

"Vertical Log" Record No.:—	Miles of Wind from:—																
	N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
1	..	..	..	..	..	..	..	..	..	..	..	..	229	69	..	..
2	..	..	..	..	..	..	..	..	..	..	..	..	27	183	21	..
3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	128	27
4	..	..	..	..	15	..	15	30	..	..	..	..	10	..	21	75
5	..	40	..	..	..	..	..	..	10	..	..	..	30	15	30	..
6	30	35	..	..	..	..	..	..	22	..	5	..	..	..	..	..
7	..	20	..	..	10	..	..	..	..	..	25	5	..	30	15	..
8	48	..	..	..	..	..	..	..	..	..	..	..	21	66	42	..
9	..	..	307	..	..	..	..	..	..	..	..	..	..	..	..	..
10	..	..	178½	82	31	..	..	..	..	..	..	..	..	..	..	..
11	..	..	..	159	..	..	..	..	..	..	..	..	..	..	..	..
12	..	..	25	..	41	30	10	..	..	..	..	..	..	..	..	..
13	..	..	..	..	..	10	..	28	60	24	24	24	..	..	..	..
14	..	..	..	..	..	..	..	..	..	..	..	24	212½	15	..	..
15	..	..	20	..	..	..	..	..	..	..	..	..	62	21	30	21
16	80	..	..	..	..	..	..	..	..	..	..	..	10	20	..	21
17	..	..	..	..	..	15	65	5	..	..	..	..	..	5	..	..
18	20	..	10	..	2	10	..	..	..	..	..	..	..	5	5	5
19	25	..	..	..	..	..	..	..	..	..	..	..	..	..	25	20
20	..	..	..	..	..	..	..	..	..	..	..	..	18	47½	40	..
21	..	..	..	10	10	25	5	..	..	..	..	..	..	..	10	15
22	..	..	..	..	..	72	..	90	21	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..	111	48	..	42	..	..	..	..	..
24	..	..	..	..	..	..	77	69	31	70	31	31	..	..	..	..
25	..	..	..	..	..	..	..	112	78	35	77	..	..	..	..	..
26	..	..	..	..	..	..	..	..	102	10	15	..	..	..	15	10
27	..	..	..	..	..	..	..	..	115½	..	97	..	..	5	10	..
28	..	..	..	..	..	..	..	..	96½	62	27	119	..	..	..	..
29	..	..	..	..	..	..	..	51	55	58	51	46	..	..	..	..
30	..	..	..	..	..	..	..	54	81	58	..	..	48	..	..	..
31	..	..	..	..	..	..	18	..	21	..	33	..	40	..	15	..
32	..	..	..	..	..	..	..	..	..	..	20	..	58½	36	10	..
33	..	..	..	..	..	..	..	112	166	..	15	..	..	..	..	..
34	..	..	..	..	..	..	..	35	42	35	127	27	..	..	..	..
35	..	..	..	..	..	..	..	62	..	..	27	69	66	..	..	..
36	..	..	..	..	..	..	..	31	27	52	78	27	18	..	..	..
37	..	..	..	..	..	..	..	..	27	27	126	147	..	..	..	..
38	..	..	..	..	..	..	..	..	..	..	..	221	54	..	..	..
39	..	5	..	..	..	..	..	..	..	..	..	..	37	15	45	..
40	..	7	..	..	..	..	2	4	2	..	..	..	..	5	5	..
41	20	20	..	..	..	..	..	..	..	..	..	..	10	..	17	10
42	..	60	..	..	..	..	40	..	..	..	..	..	..	..	..	..
43	..	..	..	..	15	92	15	10	..	..	..	..	..	..	..	..
44	31	41	77	..	..	15	..	..	..	..	..	..	..	..	..	31
45	10	..	..	..	..	..	..	..	..	..	..	97	23	..	5	42
46	..	..	..	..	..	5	35	2	2	..	..	..	..	..	5	..
47	..	..	..	..	..	45	15	..	21	42	35	..	..	..	..	..
48	..	..	..	..	..	..	..	..	..	..	31	58	139	..	..	..
49	..	..	..	..	..	..	..	..	..	..	57	..	94	..	..	..
50	..	..	..	..	..	..	..	..	..	..	21	10	66	78	..	..

Table 3 (continued).

"Vertical Log" Record No.:—	Miles of Wind from:— N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
51	..	..	..	..	..	..	80	15	10	..	..	..	..	..	..	..
52	..	..	..	..	..	5	25	20	30	..	..	..	..	..	..	..
53	..	..	..	..	..	..	..	10	..	..	25	..	40	..	..	..
54	..	..	..	..	..	..	..	21	54	30	48	15	10	..	..	..
55	..	..	..	..	..	..	..	48	63	21	69	..	..	..	..	..
56	..	..	..	..	..	..	..	30	36	..	42	30	21	..	..	..
57	..	..	..	..	..	..	..	..	15	30	36	25	30	..	..	..
58	..	..	..	..	..	..	..	..	..	5	..	79	100	..	..	..
59	..	..	..	..	..	..	..	..	..	21	5	25	72	15	..	..
60	..	..	..	..	..	..	..	..	..	..	..	..	..	15	70	40
61	..	..	..	..	..	..	..	..	..	..	..	..	..	..	54	99
62	10	..	..	..	..	..	10	..	..	..	..	..	..	5	34	5
63	..	..	..	..	..	..	35	45	15	25	..	..	..	..	..	..
64	..	..	..	..	57	63	30	15	..	..	..	..	..	..	..	..
65	..	..	..	..	..	225	..	..	..	..	..	..	..	..	..	..
66	..	..	..	..	106	45	..	..	..	..	..	..	..	..	..	..
67	..	..	..	..	208½	..	..	..	..	..	..	..	..	..	..	..
68	..	..	..	..	115½	137	..	..	..	..	..	..	..	..	..	..
69	..	..	..	25	20	..	30	..	..	..	..	..	..	..	..	..
70	..	..	..	20	40	10	..	..	..	..	..	..	..	..	..	..
71	..	..	..	..	40	90	..	..	..	..	..	..	..	..	..	..
72	..	..	..	30	..	15	..	20	50	..	..	..	..	..	..	..
73	5	..	..	..	..	..	..	..	24	..	..	..	..	..	17	..
74	..	..	..	..	..	9	2	..	9	..	10	..	..	..	..	..
75	..	..	..	..	..	..	51	102	20	..	..	..	..	..	..	..
76	..	..	..	..	..	..	..	..	15	105	..	..	15	..	..	..
77	..	..	..	..	..	5	..	..	..	..	15	..	80	..	..	..
78	5	..	..	..	..	5	40	..	30	..	5	..	..	10	..	..
79	5	..	5	..	20	30	15	..	..	..	30	..	..	..	..	..
80	..	..	..	..	..	..	..	..	45	..	15	..	15	50	..	..
81	..	..	10	..	30	..	..	..	35	..	..	..	..	25	..	..
82	66	..	72	..	10	..	..	..	..	..	..	..	..	..	..	..
83	..	..	..	..	..	..	2	..	..	..	122	..	2	..	5	..
84	..	..	..	..	..	..	..	..	..	..	..	..	5	..	31	..
85	..	..	..	..	..	..	..	..	..	..	..	..	..	40	30	..

Carruthers and Hodgson deals with similar fluctuations in the herring of the East Anglian Autumn Fishery and certain physical conditions, and the other (by the present writer) is a brief note on plaice fluctuations in the southern North Sea.

A perusal of these two papers will show it to be more than probable that if such data as we have tabulated above were forthcoming from a goodly number of lightships, we should be in possession of information which could be used to very good effect indeed in the study of fish fluctuations.

Observations in Winter 1936/1937.

The following are the bare summaries of current-meter data for winter 1936/1937 which were referred to above, and it is to be remarked that not a minute was lost during the observations at the Sandettié which lasted for 87 lunar days. In the case of the Galloper, results are missing for only 1½ days and that for no reason to do with the instrument. Relevant wind data tables are available but are not presented here.

In all cases it is the mean residual current in miles per lunar day towards a true direction which is given, and the place-names in brackets are (as in Tables 1 and 2 above) for convenience in visualizing the directions.

Sandettié Lightvessel.

December 1936...	1·6	N. 47° E.	(Helder)
January 1937	6·5	N. 33° E.	(Hanstholm)
February 1937 ...	2·8	N. 39° E.	(Ringkiobing)
Winter 1936/37...	3·7	N. 36° E.	(Nissum)

Galloper Lightvessel.

December 1936...	1·2	S. 49° W.	(Margate)
January 1937	11·1	S. 33° W.	(South Foreland)
February 1937 ...	2·7	S. 36° W.	(Deal)
Winter 1936/37...	5·2	S. 35° W.	(Deal)

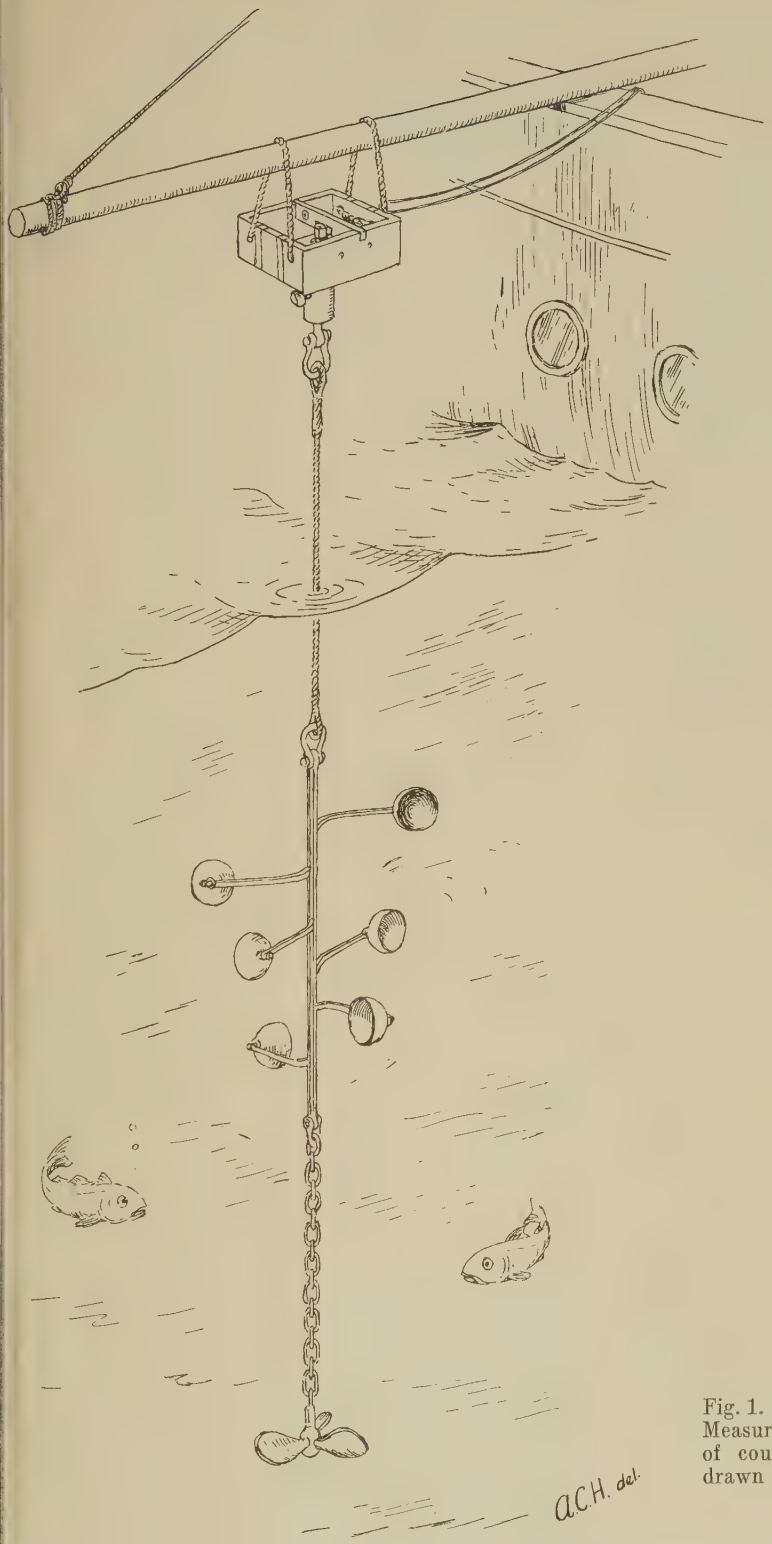


Fig. 1. The "Vertical Log" Current-Meter. Measuring Unit. (Note: The counter should of course face towards the ship; it was drawn as shown merely for the artist's convenience.)

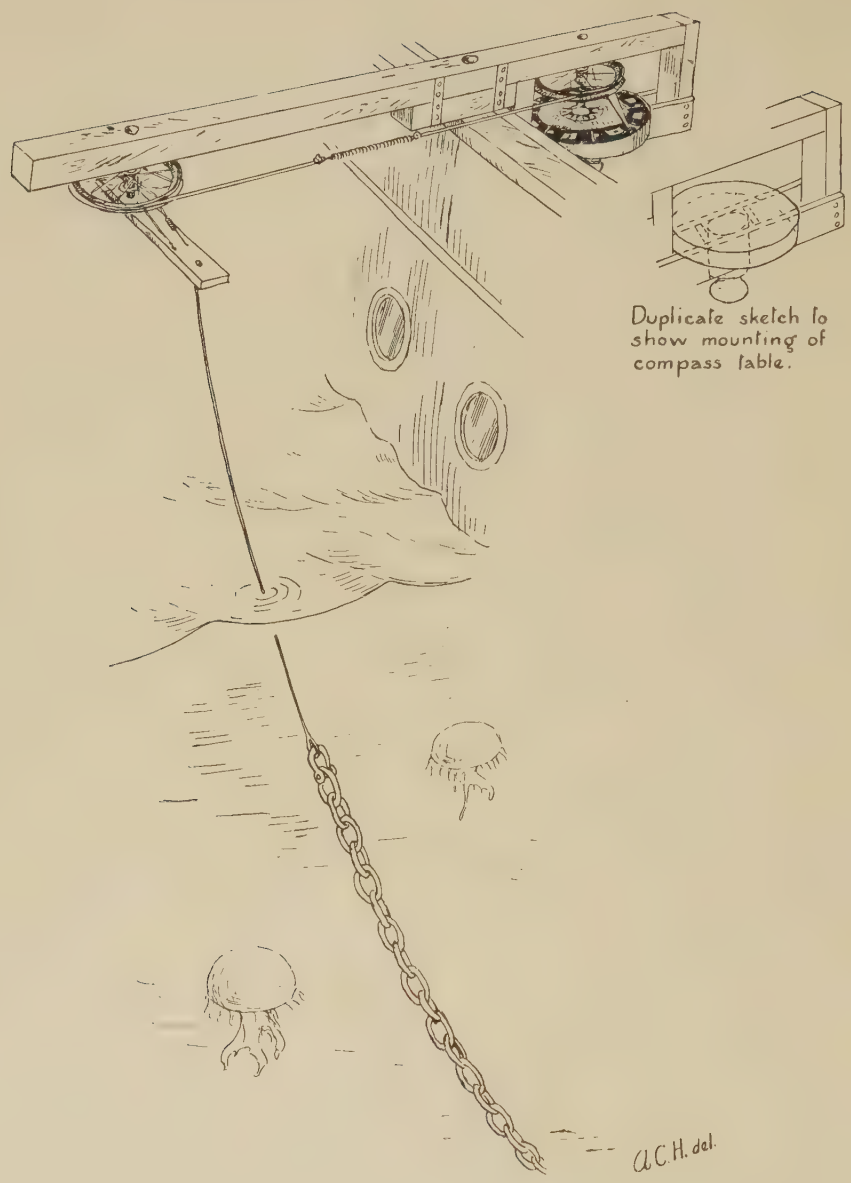


Fig. 2. The "Vertical Log" Current-Meter. Direction-viewing Unit.

It would seem from a comparison of the Sandettié data for winter 1936/37 with those for winter 1935/36, that the eggs and young stages of plaice would be spread further afield in the later winter, and this expectation would gain support from a study of the contemporaneous Varne Drift Indicator data.

It will be of interest to learn later how the two broods fared.

Appendix.

Thanks to the kindness and artistic skill of Professor A. C. Hardy, it is now possible to present illustrations showing what the "Vertical Log" current-meter looks like as rigged for use on board a lightship.

The direction-viewing unit shown in the above illustration is not, as was the corresponding accessory exhibited in Copenhagen and Edinburgh, restricted to use from a position on the stern-rail. It can conveniently be used from the side of the ship not far from the measuring unit, and it is now possible to use two instruments at the same time from one ship. They can be kept working at different depths — one from each side. Previously, at times of slack water, it was necessary to watch the drag-line to see that

did not foul the rudder-pendants. Also, under certain circumstances during a weather tide, the drag-line would be driven under the ship's quarter. When this happened, the pointer which travels over the wooden compass table was not able to swing round far enough to indicate what counter was called for. It became necessary therefore to use judgement instead of a mere glance being sufficient.

It is seen that the present device removes such difficulties; no matter how the stream sets with regard to the ship's length, only a glance at the hand-set compass is necessary in order to learn which counter should be in registration. There is the additional advantage that there is no longer any need to peer over the ship's side when observing the direction of the stream. This is important on rough dark nights. Also, with this new accessory the compass can be more easily set because the observer can get behind it. This being so, it can be much more easily illuminated when dark. If thought advisable, there is no reason why the chain shown in the illustration should not be replaced by a narrow cylinder (cf. Jacobsen's Libelle-Meter) though the chain was chosen as very conveniently suiting the length of the underwater part of the measuring unit.

The illustration is sufficiently self-explanatory as to need no detailed description, and details of construction would be gladly supplied.

The wheels are ordinary perambulator wheels and the belt is a length of sash-cord with a spring let into it so that the tension will be satisfactory whether the cord is wet or dry. The wooden slat beneath the outboard wheel takes all strain by virtue of stout bushes which fit snugly over the bolt. No strain comes on to the wheel which is orientated by the slat through spring-loaded cords or thin stranded wires. The suspension is ordinary stranded (water bottle) steel wire. Dimensions can be estimated from the statement that the compass table is 34 cms. in diameter, and it should be added that the compass is protected in use by a sheet of celluloid.

The following illustration from a photograph by Dr. W. C. Hodgson shows how the master-counter is fitted. This counter is not a rotating one but is of the type known as "stroke-counters". It works without interfering in the least with the free changing of the eight small counters.

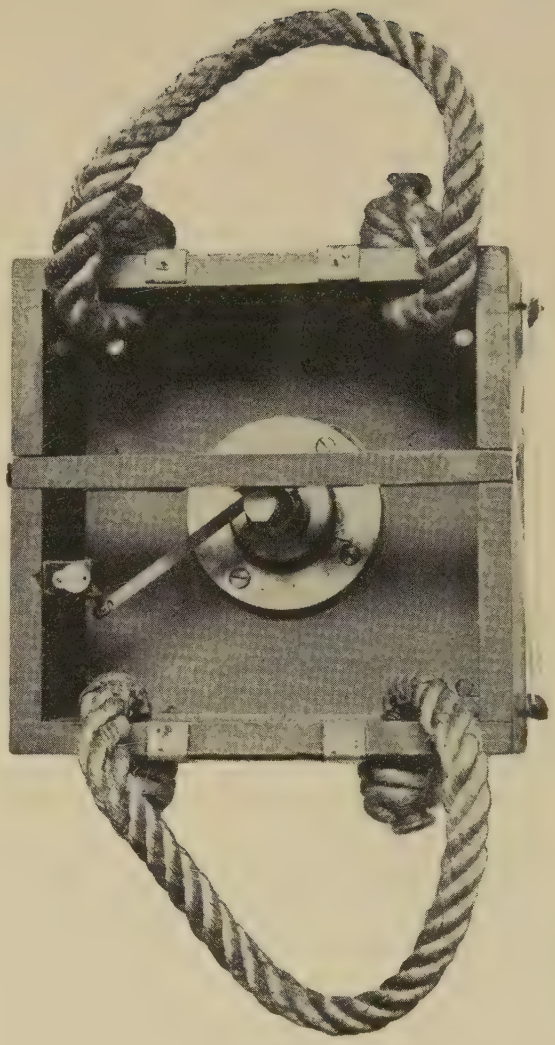


Fig. 3. Showing the Master-Counter used with the "Vertical Log".

Costs.

The instrument as shown in Fig. 1 costs the sum of £ 17. 19. 0 d. which is net and includes packing f. O. R. Beccles. It covers the supply of everything shown (cup system, propeller, and chain all galvanized) save the boom which is only a piece of cheap scaffold pole. With it go, besides the eight revolution counters, two extra ones as spares and also one spare driving cup.

If the master-counter and its fitment be also supplied, an extra charge of £ 1. 10. 0 d. is made — making in all the sum of £ 19. 9. 0 d.

It is to be regretted that the price has not turned out to be a good deal less, but this will presumably always be the complaint with oceanographical apparatus for which there can only be a limited demand and which cannot be ordered in quantities at one time. Since this article was written there has been an increase in metal prices which may possibly be reflected in the future cost of the instrument.

As already stated, the accessory shown in Fig. 2 is made in the Laboratory. The construction is quite easy and costs little.

7.

Résultats d'une année de recherches quantitatives sur le Phytoplancton de Monaco.

Comparaison avec les mers voisines.

Par

Francis Bernard,
Institut Océanographique, Paris.

L'amélioration récente des techniques de dosage[1]) a montré l'insuffisance des anciens procédés de numération des Protistes marins. Cela est particulièrement vrai en Méditerranée, où les groupes dominants, c'est-à-dire des Flagellés, échappent en partie aux méthodes de filtration ou centrifugation employées jusqu'ici dans cette mer.

Le seul travail où le procédé moderne du microscope renversé soit adopté est celui d'Ercegovič (1936)[2]). Mais la zone adriatique de Split, explorée par cet auteur, est à bien des égards différente de la Méditerranée occidentale. Il convenait donc de choisir une nouvelle région d'étude.

La mer de Monaco présente l'avantage d'être déjà décrite au point de vue hydrographique et biologique. Les mesures de température et de salinité poursuivies de 1908 à 1914 par Richard, Oxner et Sirvent[3]), le mémoire de Nathansohn[4]) sur les Diatomées d'hiver et de printemps, celui de Rose[5]) sur les Copépodes, fournissent bien des renseignements utiles. Enfin, les Diatomées et Péridiniens récoltés de 1907 à 1914 font l'objet d'un important travail en cours de publication, de Pavillard[6]).

On trouvera ici un exposé d'ensemble sur les résultats de dosages du phytoplancton pendant une année entière (Février 1936—Mars 1937). Avant de les décrire, je tiens à remercier particulièrement M. le Professeur Fage, qui m'a guidé au cours de cette étude, le Dr. Richard et ses collaborateurs de Monaco, auprès desquels j'ai trouvé toutes facilités de travail, et le Dr. E. Steemann Nielsen, qui m'a initié à ses méthodes au Laboratoire du plancton, à Copenhague.

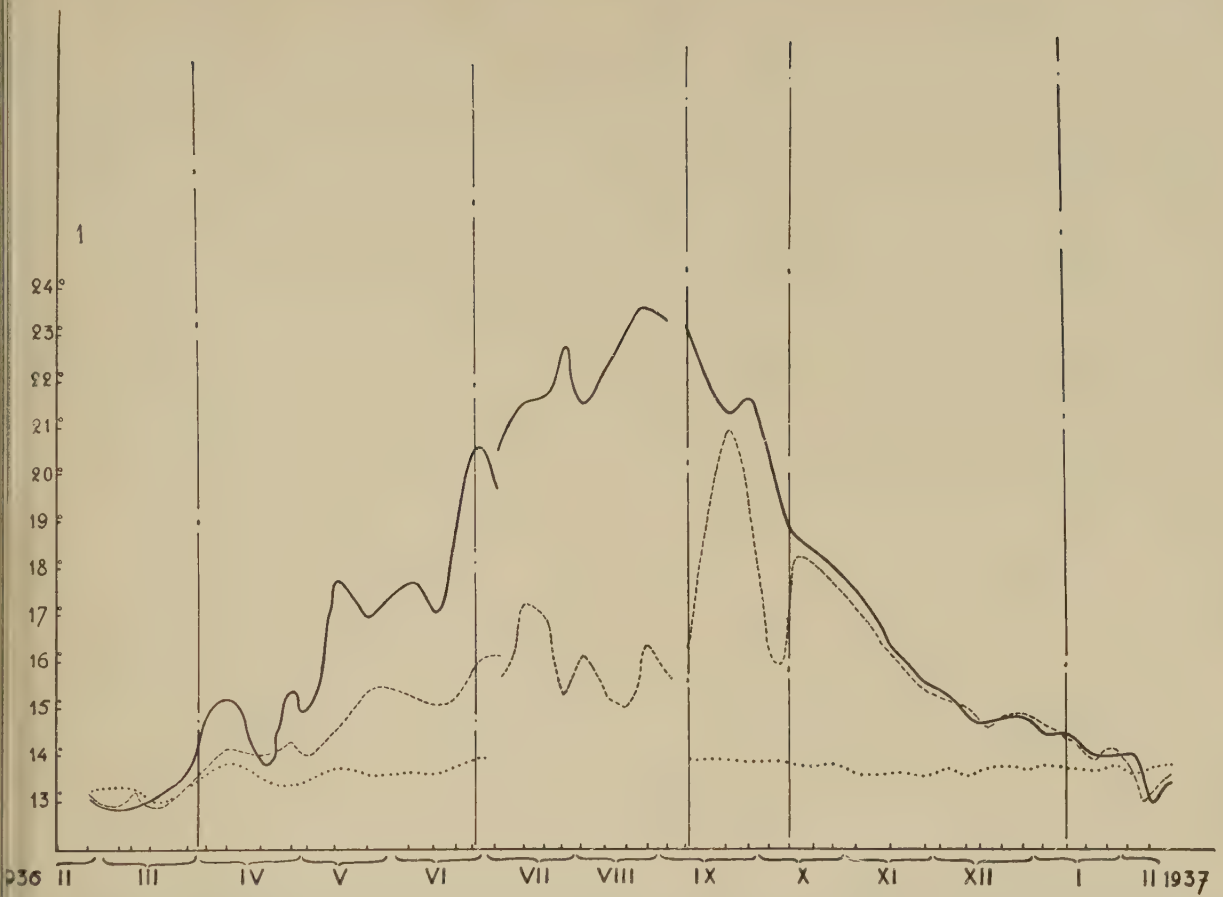
Méthode employée.

Dans une note préliminaire[7]), nous avons précisé en détail les procédés choisis. Il suffira ici d'en résumer l'essentiel: Chaque semaine, trois prises d'eau sont faites à la "Station II" située à six kilomètres SE. de Monaco, aux profondeurs de 10, 50 et 350 m., sur un fond de 444 m. Pendant les mois de Juillet et Août 1936, où le bateau "l'Eider" fut immobilisé, les prises furent faites à la "Station I", située à trois kilomètres du rivage par un fond de 228 m. Ces deux stations, d'après les nombreuses mesures hydrographiques, ne diffèrent pas beaucoup en été (le 7 Juillet, leur nanoplancton était pratiquement identique).

Les prises sont exécutées avec une bouteille Richard d'un litre. Dans chaque échantillon, j'ai dosé les phosphates et nitrates d'après les méthodes colorimétriques classiques de Denigès. Les silicates ont été dosés par le procédé de Diénert au molybdate. Le phytoplancton est dénombré au microscope renversé, après sédimentation de 14 cm.^{3} d'eau dans des vases à fond mince.

Monaco possède une station météorologique où les vents et la pluie sont enregistrés. La connaissance de ces facteurs m'a rendu grand service. Le graphique No. 2 indique les pluies en 1936—37. On remarquera l'abondance exceptionelle des précipitations en Janvier—Mai 1936, et leur rareté en hiver 1937.

[1]) E. Steemann Nielsen. Journ. du Conseil, VIII, No. 2, 1933.
[2]) A. Ercegovič. Acta Adriatica, p. 1—126, Split 1936.
[3]) Bull. Inst. Océanogr., No. 160, 413 et 436 (1923 à 1932).
[4]) Ann. Inst. Océanogr., t. I, V, 1912.
[5]) Ibid., t. III, p. 162, 1926.
[6]) Bull. Inst. Océanogr., No. 654 et 712, 1935—36.
[7]) Ibid., No. 701, 1936.



Graphique 1. Températures de l'eau à 10 m. (—); 50 m. (-----) et 350 m. (....) de profondeur, du 26 Février 1936 au 22 Février 1937. Du 7 Juillet au 1er Septembre, les dosages proviennent de la Station I, le reste de l'année ils sont faits à la Station II. Les traits verticaux ponctués —·— séparent les principales phases thermiques.

Le déversement des eaux douces se fait en partie au dessous du niveau de la mer, par les fissures des hautes falaises côtières. Plusieurs de ces sources sous-marines sont relativement profondes; l'une d'entre elles est repérée, vers 300 m. de profondeur, à proximité de la frontière italienne. Il en résulte un régime très spécial pour les courants littoraux.

La salinité n'est connue que par les dosages déjà cités d'Oxner. Il semble que ses variations en profondeur soient faibles: seules les couches superficielles (de 0 à 25 m.) présentent, après les pluies, quelques "trous de dessalure" d'emplacement très variable. A l'exception de ces zones limitées, la salinité ne change pas régulièrement avec les saisons: les chiffres d'Oxner, notamment, ne montrent pas une augmentation de salinité en surface pendant l'été.

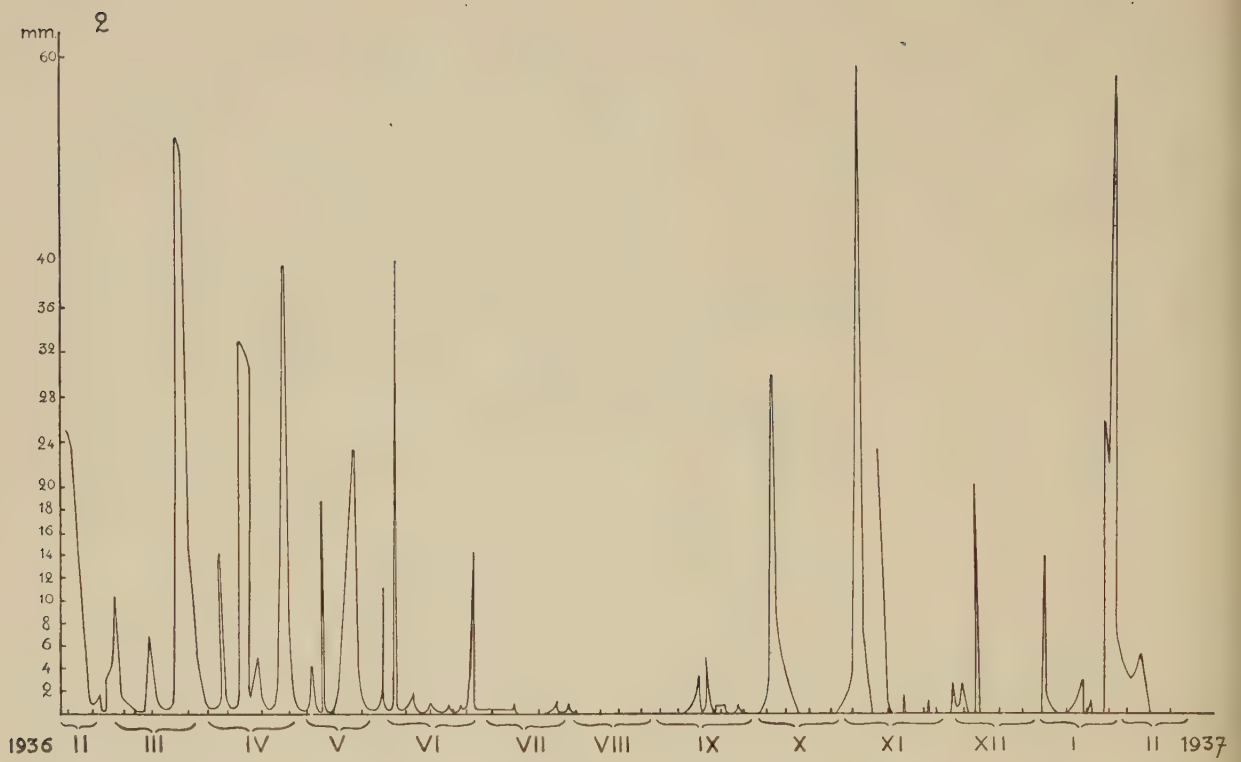
Dans une mer sans marées, en un lieu dont la salinité est relativement peu variable, la température est le facteur essentiel des échanges biologiques. C'est elle qui arrête ou favorise les déplacements de liquide, qui règle la vitesse de croissance ou de migration des êtres, qui retarde ou accélère la décomposition des cadavres.

Il est donc essentiel de rappeler d'abord les principales périodes thermiques annuelles (Graphique No. 1):

(a) *Phase d'isothermie:* du 15 Janvier au 1er Avril, la température est partout comprise entre 13° et 14°, de la surface jusqu'aux grands fonds. Au dessous de 200 m., cette isothermie se conserve toute l'année.

(b) *Phase de réchauffement:* il y a lieu de distinguer un réchauffement rapide, du 1er Avril au 1er Juillet, et un réchauffement inégal ensuite: pendant cette dernière période, la couche de 10 mètres monte de 20° à 23·70°, mais celle de 50 m. se maintient entre 16° et 17°: ce retard est très probablement dû à l'arrivée incessante d'eau profonde plus froide.

(c) *Grandes oscillations thermiques dans la zone moyenne:* pendant que la surface commence à se refroidir, la température à 50 m. oscille entre



Graphique 2. Pluviosité en millimètres à Monaco.

16° et 21°, puis rejoint, le 12 Octobre, celle de 10 mètres (18·4°). Ces variations ne sont pas un accident spécial à 1936: on les retrouve, plus ou moins accentuées, dans les mesures de Richard (1908—1914), toujours au début de l'automne. Elles sont encore plus grandes à 25 m. qu'à 50 m. Je serai d'accord avec Rose pour y voir des modifications brusques dans le sens des échanges verticaux de liquide.

(d) *Phase de refroidissement graduel:* du 12 Octobre au 15 Janvier, la température des couches de 10 et 50 m. devient homogène et diminue très progressivement, jusqu'à rejoindre celle de 350 m. et des profondeurs plus grandes.

Ces phases sont reportées en traits ponctués sur les graphiques 1, 3 et 4.

I. Volume total du Phytoplancton à Monaco. (Graphique 4).

Au point de vue de la quantité de nourriture offerte aux animaux, c'est le volume total du phytoplancton par litre qui importe, plus que le nombre des cellules.

On trouvera dans le tableau I et dans la partie systématique des exemples relatifs à ce dernier nombre; par ailleurs, il sera surtout question du volume occupé par les Protistes.

J'ai tenté l'évaluation de ce volume en calculant les dimensions moyennes de plusieurs centaines d'individus des espèces les plus communes. Voici, entre autres, quelques uns des résultats obtenus:

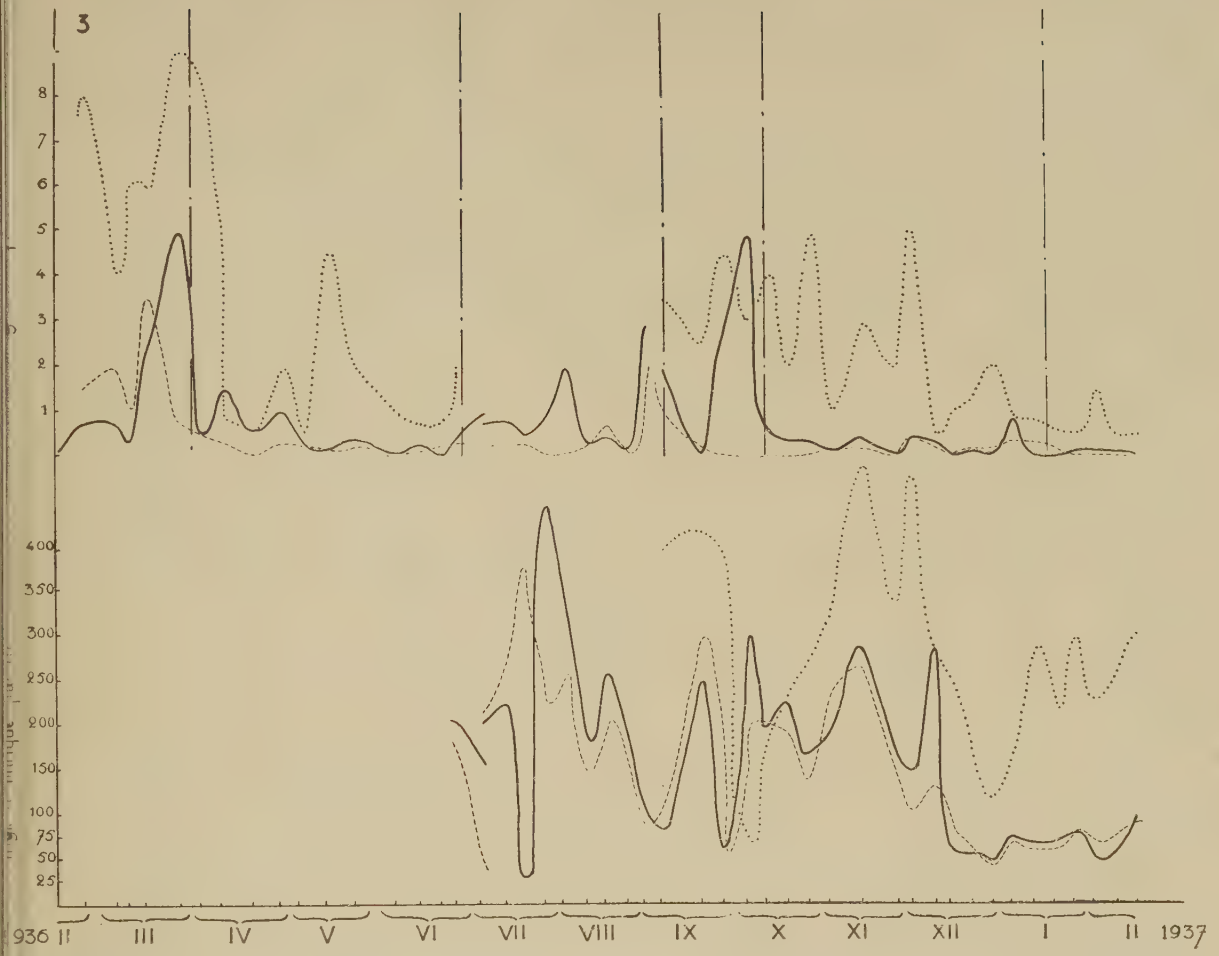
Petits Flagellés nus: volume moyen, 14 μ^3 par cellule

Petits Coccolithophorides (*Pontosphaera*, *Calyptrosphaera* etc.).....	70
Grands Coccolithophorides (*Syracosphaera*, *Coccolithus* etc.)	3,600
Gymnodiniens communs	900
Diatomées	
Nitzschia delicatissima	34
Thalassiothrix nitzschioides	1,500
Chaetoceros et *Bacteriastrum*.....	1,800

Il est intéressant de considérer la moyenne des volumes totaux pour toute l'année (48 prises d'eau pour les couches de 10 et 50 m., 37 seulement à 350 pour laquelle Juillet—Août manquent):

Volumes moyens annuels du phytoplancton	à 10 m.	0·188 mm.³	par litre
	à 50 -	0·176 —	- -
	à 350 -	0·196 —	- -

Ces nombres, on le voit, sont très voisins (la valeur pour 350 m. doit être en réalité légèrement plus faible, car les mois absents se placent à la période estivale pauvre en plancton). Il en résulte que la



Graphique 3. En haut: variations des phosphates à Monaco, en milligrammes P_2O_5 par mètres cube d'eau. En bas: variations des nitrates, en milligrammes N nitrique par mètre cube (mesurées seulement à partir du 29-VI-1936).

nasse de substance vivante est à peu près également épartie, au cours d'une année entière, entre les iverses couches étudiées.

Les maxima absolus observés sont les suivants:

à 10 m.: 0·51 mm.³ par litre (le 25-I-37)
à 50 - 0·46 — - - (le 27-VIII-36)
à 350 - 0·83 — - - (le 14-XI-36)

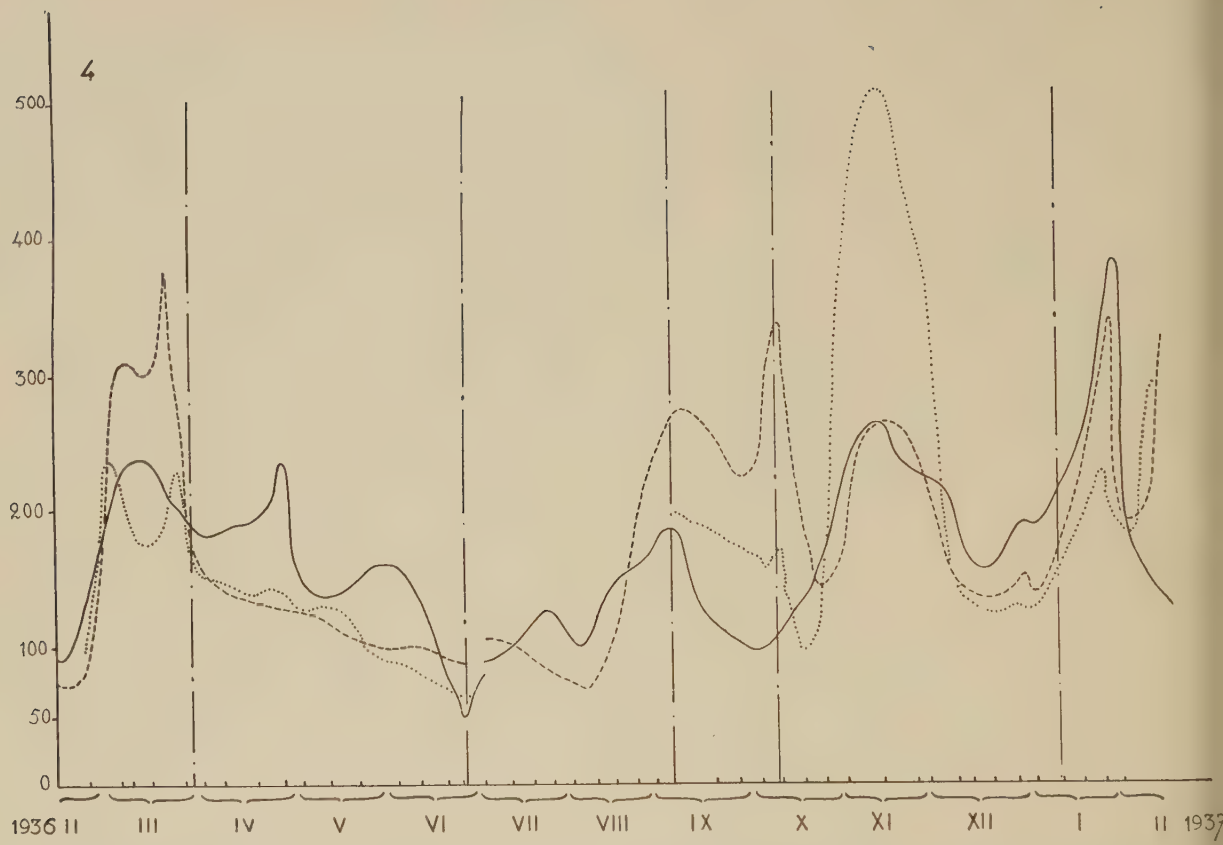
uant aux minima, ils se produisent tous en été:

à 10 m.: 0·03 mm.³ par litre (le 29-VI-36)
à 50 - 0·05 — - - (le 11-VIII-36)
à 350 - 0·04 — - - (le 29-VI-36)

C'est donc à 350 m. que l'amplitude des variations lanctoniques est la plus grande: si l'on prend égale 1 la valeur minimum, on constate que le maximum nnuel atteint 21 à 350 m., 17 à 10 m. et 9 seulement à 50 m.

Dans l'ensemble de l'année, les densités planctoniques des trois couches varient à peu près parallèlement (Graphique 3):

(a) *Phase d'isothermie:* maximum hivernal en Janvier, minimum en Février, maximum printanier en Mars;
(b) *Phase de réchauffement rapide:* appauvrissement graduel en profondeur; à 10 m., deux poussées notables dues aux apports côtiers de surface; minimum général le 29 Juin;
(c) *Phase de réchauffement inégal:* les couches de 10 et de 50 m. varient de façon analogue: sans doute, la grande différence de température favorise-t-elle les échanges verticaux;
(d) *A la fin de Septembre:* maximum à 50 m., et au contraire minimum à 10, pendant que la couche de 350 m. s'appauvrit graduellement;
(e) *La période de refroidissement* présente deux phases distinctes:



Graphique 4. Volume total du phytoplancton, en hectomicrons-cubes par litre d'eau.
(— à 10 m.; ----- à 50 m.; ..... à 350 m.). La courbe est une courbe moyenne des valeurs obtenues.

1. En Novembre, poussée générale, avec grand maximum à 350 m.
2. Après cette phase, minimum de Décembre, puis maximum général de Janvier.

En résumé: le volume total du phytoplancton se comporte de façon analogue aux trois profondeurs étudiées, sauf au début de l'automne, où de grandes oscillations thermiques à 50 m. se terminent par un maximum de Protistes localisé à cette zone.

II. Importance relative des divers Protistes dans l'eau de Monaco.

(Graphiques 5, 6, et 7).

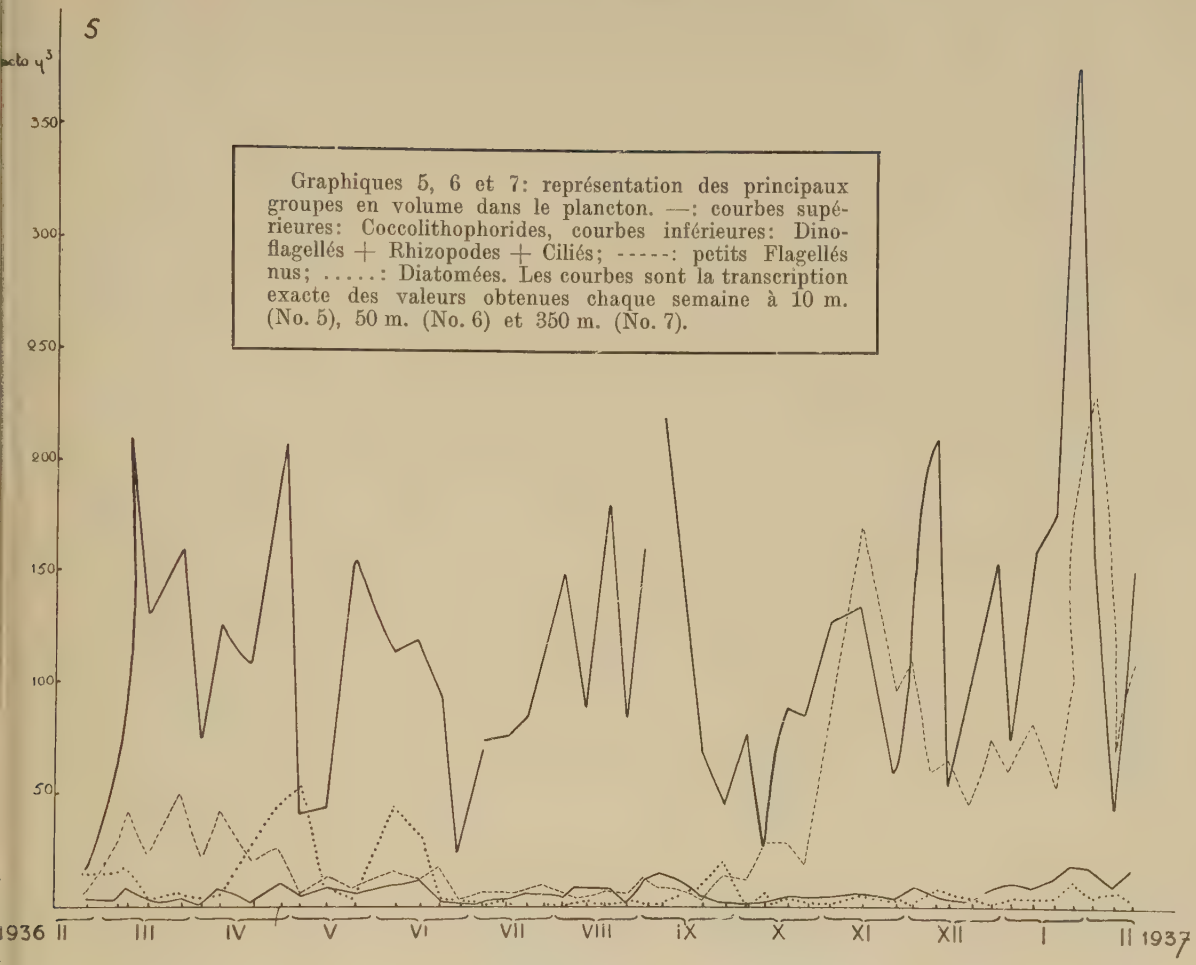
Petits Flagellés sans Carapace. — Ce groupe, constitué surtout par les Chrysomonadines, est le plus nombreux en individus (200,000 à 28 millions par litre), mais, par suite de leur faible taille (3 à 20 μ), ils ne représentent pas en volume la majorité du nanoplancton. Peu abondants au printemps, rares en été, ils font une poussée considérable en Novembre et en Janvier.

Normalement, presque toutes les cellules observées ont des plastes jaunes, mais, en grande profondeur et aussi en surface en Novembre, il y a majorité de formes incolores. Le dosage des substances organiques dissoutes, si sa technique était mieux au point, nous renseignerait sans doute sur les conditions de nutrition de ces Flagellés hétérotrophes.

Coccolithophorides. — Comme l'ont montré Lohmann (1903, 1911)[1]) et Schiller (1925)[2]) ce sont les Coccolithophorides qui jouent le rôle quantitatif essentiel en Méditerranée. Les petites espèces des genres *Pontosphaera* et *Calyptrosphaera* occupent, malgré leur nombre (30,000 à 2 millions par litre), un volume moins grand que les gros *Syracosphaera*, *Acanthoica* et *Coccolithus* (6,000 à 110,000 cellules par litre).

Au total, le volume de ces Flagellés calcaires fait à Monaco 40 à 95 % du total des Protistes par litre. Il dépasse largement celui des

[1]) H. Lohmann. Wiss. Meeresunters. Kiel. Bd. 7, 1903; und Internat. Rev. Hydrob. und Hydrogr., Bd. 4, 1911.
[2]) J. Schiller. Arch. für Protistenkunde, t. 51, p. 1-130, 1925.



Graphiques 5, 6 et 7: représentation des principaux groupes en volume dans le plancton. —: courbes supérieures: Coccolithophorides, courbes inférieures: Dinoflagellés + Rhizopodes + Ciliés; -----: petits Flagellés nus; .....: Diatomées. Les courbes sont la transcription exacte des valeurs obtenues chaque semaine à 10 m. (No. 5), 50 m. (No. 6) et 350 m. (No. 7).

utres groupes, sauf en Avril où les Diatomées de urface ont un faible maximum, et en Novembre où, arfois, les Flagellés nus l'emportent.

Les genres dominants sont *Syracosphaera* (surtout . *pulchra, mediterranea*) et *Calyptrosphaera* (*C. oblonga, haeroidea*); ils sont pérennes et constituent l'essentiel u plancton d'été. Les formes plutôt océaniques: *ontosphaera* et *Coccolithus*, peuvent apparaître en asse au printemps et en automne, mais jouent un le secondaire le reste de l'année. Quant aux autres nres de Coccolithophorides, leur rôle quantitatif t négligeable; je signalerai toutefois la présence équente, de Mars à Novembre, du genre tropical *iscosphaera* (*D. tubifer, Thomsoni*), dont le nombre cellules au litre ne dépasse pas mille.

Il est possible d'évaluer la vitesse de déplacement ces êtres: un *Syracosphaera* vivant parcourt en oyenne 0·3 mm. par seconde, soit quinze fois son amètre: il pourra donc faire, en eau calme et en oite ligne, 30 m. par jour environ. Ces considérations nnent une idée des possibilités de migration active nanoplancton.

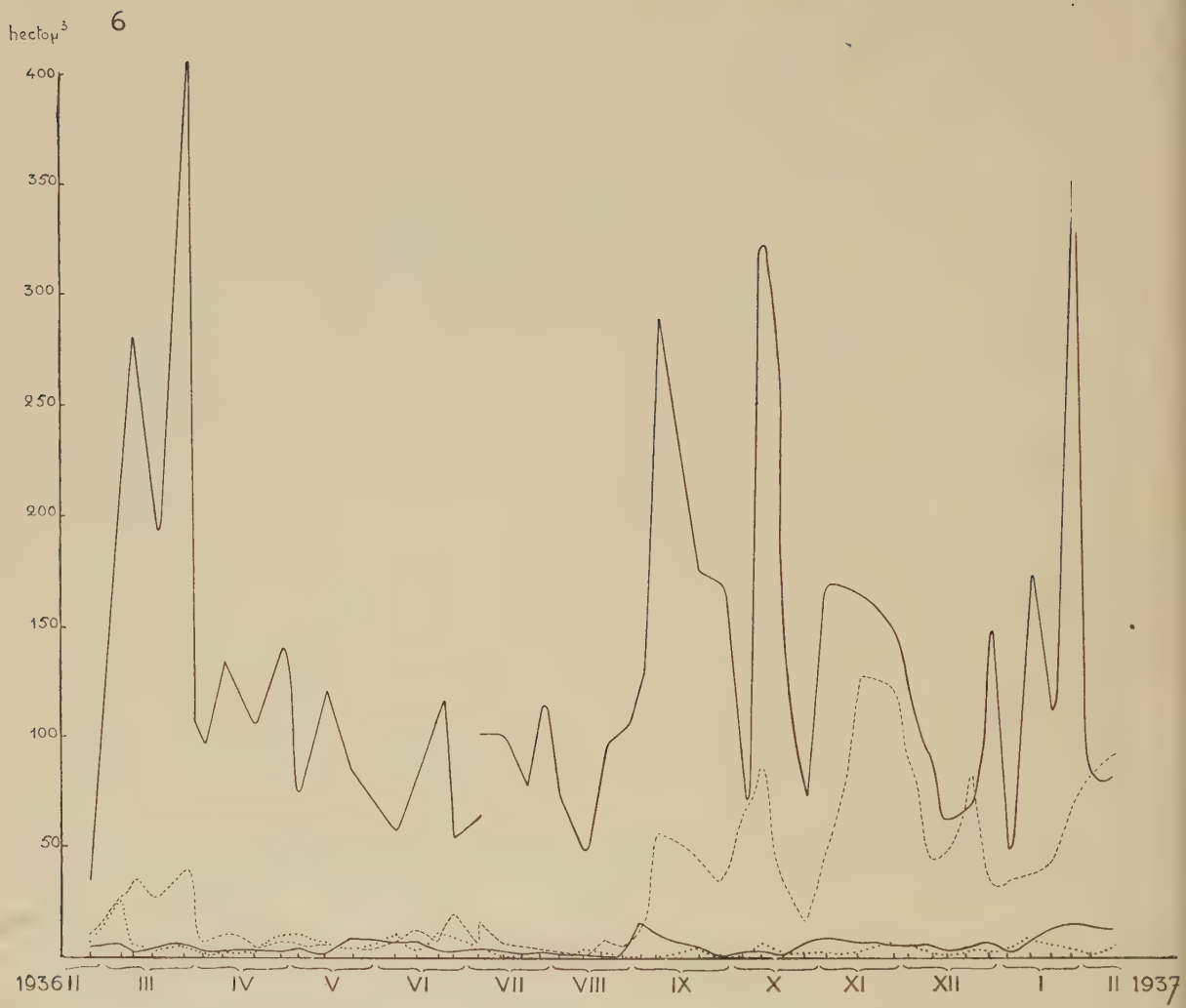
Diatomées. — Ce groupe n'a qu'un rôle très faible à Monaco, ainsi qu'il ressort des graphiques ci-joints. Au point de vue systématique, les Centriques pélagiques (*Guinardia, Leptocylindrus, Rhizosolenia, Chaetoceros*) sont très sporadiques et superficielles à Monaco. Nathansohn (l. c.) a montré que les *Chaetoceros* y apparaissent surtout après les pluies, ce qui est confirmé en grande partie par mes observations.

Le seul groupe de Diatomées pérennes dans les eaux du Golfe de Gênes (d'après Issel[1]) et nous-même) comprend les *Thalassiothrix* et des formes semi-pélagiques comme *Nitzschia longissima*.

Il y a enfin des Diatomées benthiques côtières (*Navicula, Gyrosigma*, etc.), souvent entrainées au large par les courants. Ce sont d'utiles indicateurs de la provenance côtière des eaux (Graphique 8).

Le maximum printanier d'Avril correspond à 54,000 cellules de Diatomées par litre, dont la majorité sont de très petites espèces comme *Nitzschia delica-*

[1]) R. Issel, 1925. Riv. Com. Talass. Ital., Mem. CXV.



tissima. Habituellement, l'eau de Monaco ne contient que 2,000 à 3,000 Diatomées par litre.

Autres groupes de Protistes. — Les diverses formes ci-dessous sont encore moins abondantes que les Diatomées. Parmi les Dinoflagellés, seules les Thécatales (*Exuviella*) et les Gymnodiniales sont pérennes, avec un maximum en Septembre (espèces tropicales) et un autre en Janvier (espèces d'eaux tempérées). Leur nombre par litre va de 1,000 à 20,000 cellules; les *Ceratium* atteignant au plus 500. Les Silicoflagellés présentent un maximum de 3,000 individus par litre en Mars à 50 m.: la seule forme fréquente est *Dictyocha fibula*.

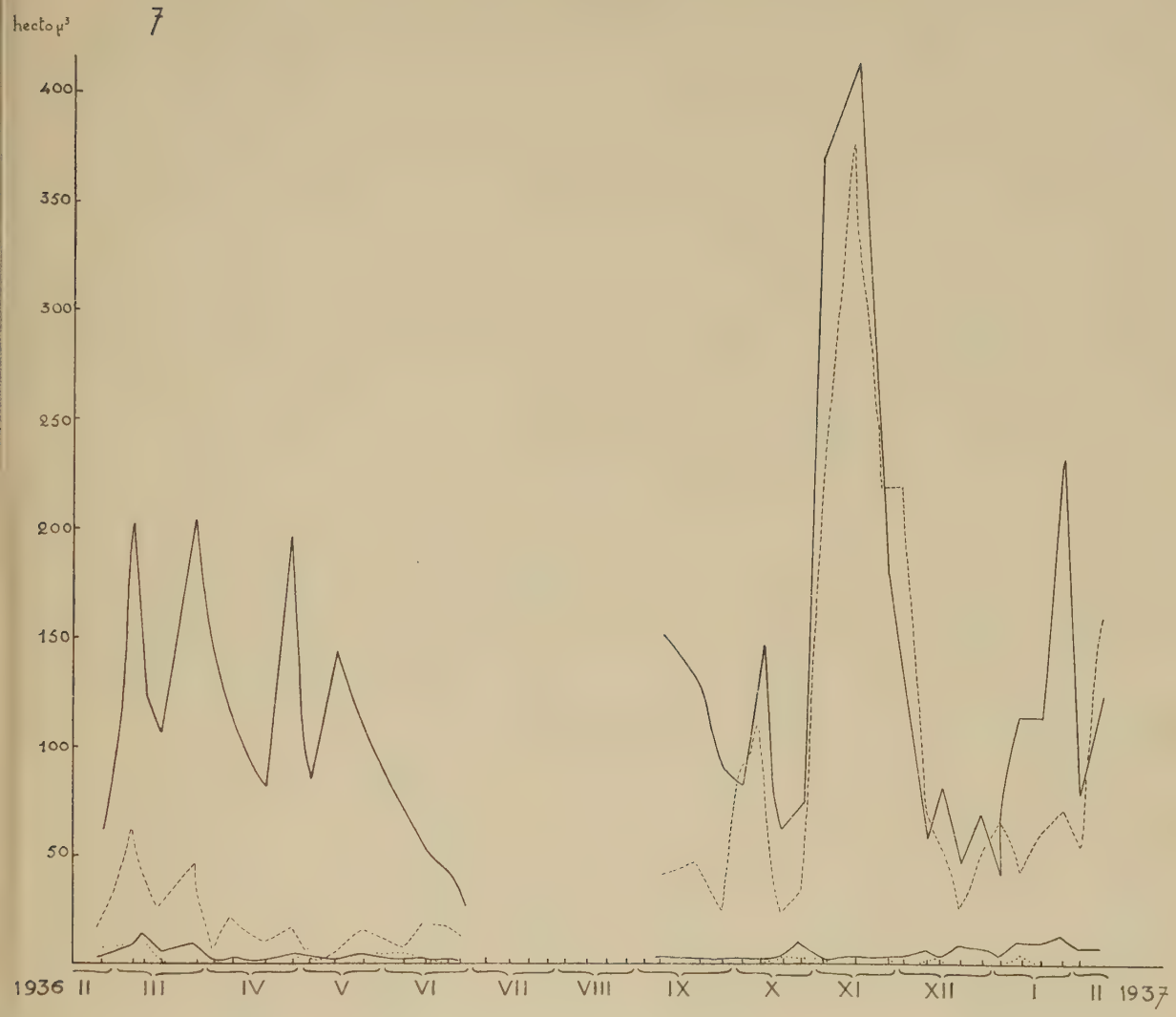
III. Cycle annuel des sels Nutritifs.

(Graphique 3).

Les premiers dosages valables de ces substances en Méditerranée sont dus à Thomsen[1]), au cours de la croisière du "Dana" en Avril—Juin 1930. Notons tout de suite que cette croisière ne fournit pas de station directement comparable avec Monaco: en grande majorité, les prises ont été faites dans le sud de la Méditerranée, loin des côtes, à une époque chaude et sèche de l'année. L'ensemble de ces trois facteurs cadre avec une diminution des apports nutritifs, et il ne faut pas s'étonner des valeurs très faibles trouvées par Thomsen dans les couches superficielles, où les phosphates et nitrates manquent complètement dans certains cas.

Phosphates. — Pour ces sels, Ercegović (1936) a publié le résultat des dosages faits à Split. En présence de ceux-ci, de ceux de Thomsen et de ceux que j'ai faits à Monaco et à Banyuls, je puis confirmer la grande pauvreté de la Méditerranée, même très près des côtes: le maximum observé à 10 m. est à peine de 5 mg. (P_2O_5) par m.³; à 50 m.: 3 mg.; à 350 m.: 9 mg.

[1]) H. Thomsen, 1931. Report of Dan. Exp. to Medit., t. 10, fasc. 7.



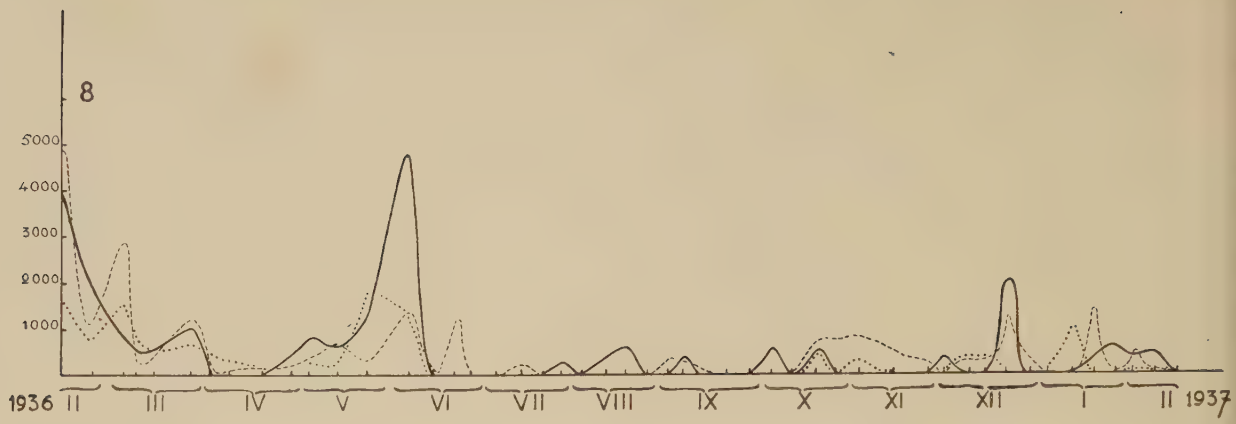
à 10 m.: moyenne annuelle: 0·8; minimum: 0 (assez souvent)
à 50 m.: moyenne annuelle: 0·4; minimum: 0 (très souvent)
à 350 m.: moyenne annuelle: 2·7; minimum: 0·5 (assez souvent).

Cette pauvreté tient d'abord à ce qu'il s'agit d'une mer fermée, sans grands échanges avec l'Atlantique et ne recevant que de faibles apports d'eau douce et de plancton: la vie s'y passe en cycle fermé, d'où la rareté des phosphates, qui, même aux très grandes profondeurs, ne dépassent pas 15 mg. par m.³.

Le cycle annuel des phosphates de Monaco se trouve être bien différent suivant les trois profondeurs étudiées (Graphique 3). En Mars 1936, l'apport des sels par les eaux douces côtières est tel que, malgré la richesse du plancton, leur teneur reste relativement forte jusqu'à la fin du mois. Puis les courants changent de direction, ce qui est confirmé par la diminution des Diatomées benthiques (Graphique 8). D'Avril à Septembre, la zone de 50 m. reste fort pauvre, malgré la décroissance planctonique. A 10 m., deux poussées notables de phosphates, en Juillet—Août, sont dues probablement à des apports de la profondeur, en l'absence de pluies.

En Octobre, une trés grande différence se constate entre les couches de 10 et 50 m., explicable par la différence, de sens inverse, déjà notée pour la teneur en plancton (Graphique 4). Puis, le maximum des Protistes, en Novembre, fait tomber trés bas la quantité de phosphates, qui ne se relève guère ensuite, en raison de la rareté des pluies de l'hiver 1936—37.

En résumé: les phosphates proviennent surtout des eaux douces en hiver et des réserves de profondeur en été. A 50 m., ils sont particulièrement rares, à peine suffisants aux poussées planctoniques enregi-



Graphique 8. Nombre de cellules par litre des Diatomées benthiques côtières (*Navicula, Gyrosigma* etc. . . .). —: profondeur 10 m.; -----: 50 m., ...: 350 m.

strées. A 350 m., ils suivent, en gros, les mêmes variations qu'à 10 m., avec des valeurs moyennes plus élevées: à cette profondeur déjà notable, ils ne tombent jamais à zéro, car la lumière y est trop faible pour amener leur épuisement par le phytoplancton.

Fait intéressant: la teneur en phosphates de la couche de 50 m. n'est pas intermédiaire entre celles des deux autres: soit qu'en hiver, les réserves du fond ne l'atteignent pas et que les apports d'eau douce n'y arrivent guère, soit qu'en été les réserves du fond remontent à la surface par un système de courants ne passant pas la verticale de la station étudiée (Station II).

En Avril et Septembre 1936, j'ai pu faire des prises d'eau à divers niveaux entre 0 et 1,000 m. de profondeur, et, à ces deux époques, j'ai trouvé une zone très pauvre en phosphates qui s'étend en épaisseur de 25 à 300 m.

Nitrates. — Je n'ai pu doser ces éléments qu'à partir du 29 Juin 1936. La moyenne d'azote nitrique par m.^{3}, du 29 Juin au 1er Mars 1937, est la suivante:

à 10 m.:	150 mg. N_2	(valeurs extrêmes:	30 et 450 mg.)
à 50 -	145 —	(—	— 40 et 380 —)
à 350 -	280 —	(—	— 70 et 480 —)

La teneur en nitrates, pendant cette période ne tombe jamais à zéro[1]), contrairement à ce qui ce passe à Banyuls (voir plus loin), où les poussées de phytoplancton sont très brusques et très intenses. D'autre part, les variations des nitrates aux trois niveaux étudiés sont parallèles, réglées surtout, semble-t-il, par celles du plancton.

En résumé, le cycle des nitrates apparaît assez différent de celui des phosphates et demande de nouvelles recherches. En tout cas, il y en a beaucoup plus à Monaco que dans les stations pélagiques méditerranéennes du "Dana".

[1]) Les nitrates ne tombent à zéro qu'en deux périodes: fin d'Avril et fin Mai.

Silicates. — L'intérêt biologique de ces sels est faible dans une mer où les organismes siliceux ne jouent qu'un rôle secondaire. Leurs variations annuelles montrent leur prépondérance en surface (comparable à celle des Diatomées et des courants superficiels apportant la silice côtière), et des teneurs plus faibles à 350 m. Les valeurs extrêmes sont les suivantes:

60 à 700 mg. SiO_2 par m.^{3}	à	10 m.,
60 à 500 —	à	50 -
60 à 350 —	à	350 -

Les maxima de silicates coincident souvent avec l'apport de grains minéraux de quartz, provenant des grès de Menton.

IV. Quelques dosages à Monaco.

Le tableau I donne quelques exemples caractéristiques de composition du phytoplancton. Les dates choisies présentent surtout des maxima ou minima de Coccolithophorides et Flagellés. Je rappelle que le plus grand développement des Diatomées, en fin Avril, correspond à 54,000 cellules par litres.

V. Comparaisons avec quelques autres stations.

A. — Banyuls-sur-Mer. — Des prises d'eau, comparables à celles effectuées à Monaco, sont faites à Banyuls sur mer (Pyrénées orientales), à trois kilomètres du laboratoire Arago, par un fond de 84 m. La série des prises à 10 et 50 m. ayant dû être interrompue en Juillet et en automne, je me contenterai ici de noter les caractéristiques propres à cette région:

Tableau I.

Exemples de dosages à Monaco (Station II) 1936—37.

N. B. Les nombres de cellules sont en milliers par litre.

Eléments	Prof. en m.	Moyenne annuelle	Maximum du 27-III	Minimum du 29-IV	Phase d'oscillations 12-X	Maximum du 14-IV
Température C°	10	17·2	13·70	20·70	18·80	16·35
	50	15·2	13·50	16·0	18·30	16·20
	350	13·5	13·30	13·95	13·80	13·70
Phosphates mg. P_2O_5 par m.³	10	0·8	5·0	0·5	0·7	0·5
	50	0·4	0·7	traces	0	traces
	350	2·7	9·0	2·0	4·0	3·0
Nitrates (dosés du 7-VII au 1-III) (mg. N nitrique par m.³)	10	150	..	210	200	290
	50	145	..	180	200	270
	350	280	..	230	160	570
Petits Flagellés nus	10	3,050	3,500	220	2,100	11,900
	50	2,730	6,500	1,400	6,000	8,800
	350	4,600	3,000	900	8,000	26,800
Petits Coccolithophorides (*Pontosphaera, Calyptrosphaera*)	10	381	860	30	240	700
	50	321	715	70	440	480
	350	370	790	40	280	800
Grands Coccolithophorides (*Syracosphaera, Coccolithus*)	10	29·4	45	7·2	8	38
	50	31·4	100	14·0	80	36
	350	29·2	42	6·6	35	110
Diatomées Centriques pélagiques	10	3·2	0	1·0	0·3	2·4
	50	0·68	0·2	0	0·3	0
	350	0·13	0·7	0	0	0
Diatomées sub-pélagiques (*Nitzschia, Thalassiothrix, Asterionella*)	10	2·8	1·5	0	9·0	0·3
	50	1·9	1·8	0	8·4	0·3
	350	0·32	0·1	0	0	0
Diatomées benthiques côtières (*Navicula, Gyrosigma*)	10	0·40	1·0	0	0	0
	50	0·38	1·2	0	0	0·6
	350	0·28	0·7	0	0	0
Thécatales (*Exuviella*)	10	1·1	1·6	0·6	0·3	0·3
	50	0·77	2·0	1·2	0	0·6
	350	0·87	1·5	0·6	0·3	0
Gymnodiniales	10	3·9	3·6	0·6	2·7	6·0
	50	3·4	4·0	1·8	3·9	4·5
	350	2·3	3·8	1·2	0·1	3·6
Total du nombre de cellules par litre	10	3,475	4,416	261	2,360	12,650
	50	3,091	7,327	1,488	6,533	9,325
	350	5,004	3,842	950	8,316	27,714

1. — Vent dominant plus froid et plus sec qu'à Monaco; pluies moins fréquentes. Températures des eaux, inférieures de 1·5° à celles de la station II à la même époque.

2. — Station tout à fait néritique, où les apports d'eau douce des torrents côtiers restent superficiels, sans grand échange avec la profondeur. En conséquence, la couche de 10 m. est presque toujours deux fois plus riche que celle de 50 m. Les variations de teneur en organismes sont très grandes et très brusques après les pluies.

3. — La teneur en Coccolithophorides est sensiblement la même qu'à Monaco. Mais les Diatomées tiennent une place beaucoup plus large, à cause de la température plus basse et des changements de salinité: le volume total du phytoplancton est de deux à cinq fois plus grand. Il en résulte des teneurs très faibles en sels nutritifs: les nitrates tombent souvent à zéro.

En somme, cette région est très différente de celle de Monaco par la circulation des eaux[1]).

B. — Adriatique. — La plupart des autres régions méditerranéennes déjà connues quantitativement se trouvent dans l'Adriatique. Schiller (1925)[2]) donne

[1]) La baie de Villefranche sur mer, à 15 km. à l'ouest de la station II de Monaco, parait avoir à 10 m. et à 50 m. une teneur en phytoplancton tout à fait comparable à celle de Monaco.

[2]) J. Schiller. Arch. f. Protistenkunde, 51, p. 1. 130, 1925.

Tableau II.

Volume du Microplancton. — Comparaison de sept régions, à la même époque (Avril—Mai). — Les volumes sont en Hectomicrons-cubes par litre.

	Prof. en m.	Monaco 4 prises du 22-IV au 13-V	Banyuls 4 prises du 21-IV au 15-V	Golfe de Gascogne 3 prises 18-IV	Parages des Açores 3 prises 25-30-IV	Parages du Sénégal 3 prises 5-8-V	D'après E. Steemann Nielsen 1935	
							Atlantique Nord Station 4402 en Mai 1933 prof. 25 m.	Eau Arctique. Côte E. d'Islande Juillet 33 3 Stations prof. 25 m.
Latitude Moyenne	..	43°42′ N.	42°20′ N.	44°59′ N.	36°30′ N.	18°36′ N.	62°23′ N.	64°36′ N.
Longitude Moyenne	..	7°29′ E.	3°14′ E.	8°13′ W.	27°58′ W.	18°10′ W.	16°05′ W.	13°58′ W.
Température Moyenne C°	50	14·3	13·7	12·1	16·1	17	11·35	5·9
	350	13·50	..	11	14·1	12·9	Prof. 25 m.	Prof. 25 m.
Total des Volumes de Coccolithophorides	50	113	127	256	470	1,043	519	2·9
	350	127	..	106	558	628	(Maximum Printanier)	..
Rapport des Coccolithophorides au volume total	50	88 %	37 %	37 %	64 %	86 %	86 %	2·3 %
	350	74 %	..	81 %	72 %	78 %	..	..
Total des Diatomées	50	8	138	69	53	3	58	119
Rapport au volume total	50	6 %	40 %	10 %	7 %	0·2 %	10 %	93 %
Dinoflagellés	50	3·3	11	188	89	66	23	3
	350	2·1	..	21	76	50	..	..
Ciliés	50	0·4	4·4	21	28	20	3	2
	350	..	..	..	..	1	..	..
Volume total par litre	50	129	345	690	738	1,220	603	128
	350	172	..	131	772	800	..	..

des nombres de Coccolithophorides au litre. Ces nombres paraissent de 10 à 100 fois plus faibles que ceux de Monaco et de Banyuls. Il est vrai que Schiller n'opérait pas au microscope renversé, mais par sédimentation puis décantation à la pipette, procédé faisant perdre de nombreuses cellules.

Toutefois, Ercegović (l. c., 1936) obtient des résultats analogues sur la côte dalmate près de Split. Au microscope renversé, le maximum annuel de Coccolithophorides au litre observé par lui n'atteint que 14,000 cellules. Par contre, les Diatomées sont largement plus abondantes qu'à Banyuls-même (maximum 440,000 cellules par litre).

Ces auteurs ne comptant pas les petits Flagellés, je n'ai pu évaluer les volumes d'après leurs tableaux.

Retenons l'analogie de l'Adriatique avec l'Atlantique Nord: dominance des Diatomées, les Coccolithophorides n'apparaissant en majorité que dans quelques zones littorales abritées (bouches de Cattaro d'après Schiller, fjord d'Oslo d'après Gran).

C. — Atlantique Nord. — En Avril—Juin 1936, le navire de recherche "Président Théodore Tissier" a fait une croisière sur les côtes du Sénégal. Les résultats globaux obtenus sur la densité du phytoplancton permettent de comparer les moyennes à celles de Monaco et de Banyuls à la même saison (voir: Tableau II).

Dans le même tableau comparatif se trouvent quelques chiffres de l'Atlantique Nord (parages de l'Islande) d'après les dosages de E. Steemann Nielsen (1935)[1]).

Pour la période considérée (Avril—Juin), l'eau à Monaco est trois fois plus pauvre qu'à Banyuls, cinq fois plus que dans les stations du Golfe de Gascogne, et cinq à dix fois plus que dans les autres stations atlantiques. La proportion des Coccolithophorides, en volume, atteint son maximum à Monaco.

Résumé et conclusions.

1. — Une série de dosages des Protistes pélagiques, portant sur plusieurs années, a été entreprise à Monaco: les premiers résultats (26-II-1936 au 1-III-1937) sont exposés ci-dessus. Chaque semaine, on prélève à la "Station II" de l'eau à 10, 50 et 350 m. Les numérations se font au microscope renversé.
2. — Le volume total du phytoplancton par litre est évalué d'après les dimensions moyennes des espèces les plus abondantes. Les moyennes de l'année montrent que les trois couches explorées contiennent des volumes fort analogues de Pro-

[1]) E. Steemann Nielsen. Medd. f. Komm. f. Danmarks Fisk. og Havunders., København, 1935.

tistes, ce qui indique des échanges verticaux importants.

3. — Le maximum de cellules se rencontre en Janvier et Mars pour les couches supérieures, en Novembre à 350 m. En général, les variations du phytoplancton sont à peu près parallèles dans les trois couches, sauf au début d'Octobre, où se produisent plusieurs décalages thermiques et biologiques très particuliers.

4. — Les seuls groupes importants au point de vue quantitatif sont les Coccolithophorides, presque toujours dominants, et les petits Flagellés nus (Chrysomonadines et formes incolores) qui ne prennent un grand développement qu'en Automne.

Les Diatomées sont relativement peu abondantes, sauf à la fin d'Avril: l'intérêt de leur capture réside surtout dans les connaissances qualitatives que nous avons du mode de vie des espèces: c'est ainsi que les formes benthiques (*Gyrosigma*, *Navicula*) servent à déceler les courants d'origine côtière. Les Dinoflagellés sont pérennes, mais en faible nombre.

5. — La côte de Monaco est formée de hautes falaises calcaires. Après les pluies, l'eau douce est déversée en partie par des sources sous-marines. Cela explique l'importance des apports nutritifs, même à une certaine profondeur, après la grande époque pluvieuse de l'hiver 1936. La présence des Diatomées benthiques déjà citée coïncide assez bien avec les enrichissements locaux en phosphates et plancton.

6. — Le cycle des phosphates est complexe. Ils ont une double origine: apports d'eau douce côtiers (surtout en hiver) et remontée des réserves de grande profondeur (surtout à la fin de l'été, quand les différences de température entre la surface et la zone profonde atteignent leur point culminant). En moyenne, la couche de 50 m. est deux fois plus pauvre en phosphates que celle de 10 m., ce qui laisse supposer des échanges verticaux insuffisants, tout au moins dans la région de station II étudiée.

Les nitrates, relativement abondants à Monaco, paraissent avoir un cycle bien différent de celui des phosphates. En tout cas, leurs variations dans les diverses couches se montrent beaucoup plus comparables. Leur maximum se place en été, saison pauvre en plancton et favorable aux remontées des eaux inférieures.

7. — A titre de comparaison, des évaluations parallèles de volume du phytoplancton ont été faites, pour la période Avril—Mai, entre les stations méditerranéennes de Monaco et Banyuls et diverses régions de l'Atlantique.

Il en résulte une pauvreté relative incontestable de la Méditerranée au point de vue de la masse des Protistes pélagiques. Qualitativement, les Coccolithophorides sont aussi variés que dans l'Atlantique tropical et représentent, comme dans cette région, la grande majorité des Protistes. L'Adriatique, seule zone méditerranéenne étudiée jusqu'ici au point de vue quantitatif, paraît plus pauvre que les côtes de France, et comparable à l'Atlantique tempéré en ce qui concerne la proportion des divers groupes.

8.

The reduction of the stock of plaice in the southern Horns Reef Area through intensive trawling in later years.

By

Aage J. C. Jensen.

How far the stock of plaice has been reduced on the nursing grounds in the southern Horns Reef Area may be studied by examination of the results of quantitative hauls made by "Kommissionen for Danmarks Fiskeri- og Havundersøgelser". In the following review the reduction of 1934—36 has been compared to that of 1925—27.

The experimental hauls have been made by the 50-feet Ottertrawl with a fine-mesh cod-end; the hauls were of 30 min. duration (in 1934—36) at stations mentioned in Tab. 1, — in 1925—27 some stations were fished for 15 min. — some for 60 min. Until 1935, the hauls were made from the "Dana", during 1936 from the "Biologen". Hauls were made from 7—9 m. depth as far out as the youngfish-stocks were present.

The 1925 and 1927 experiments were made on April 2nd to 4th and March 28—29th respectively, when the stocks reached the 20 m. and the 13 m. contours[1]). For purpose of quantitative comparison the means have been calculated of numbers caught at each station between the 10 m. and the 20 m. contours as these stations are evenly distributed, more or less, over this area[1]).

The experiments of 1934, 35 and 36 were made in early June, when the stocks reached the 25—30 m. contour. The total density has been calculated by means of catches within each zone of depths, viz. less than 10 m., 10—20 m. and 20—30 m.; these means have been added together after weighting by $^1/_3$-1-2 to account for the respective size of zone. — Experiments at less than 10 m. depth are rarely numerous, also in some years they are less reliable on account of rough weather. Comparisons of means, therefore, have been made below between 10—30 m. areas as well as 5—30 m. areas.

The quantities of plaice within each age-group in 1925—27 have been published in the paper cited above, for 1934—36 they are given in table 1 (10—30 m. area).

[1]) Medd. f. Komm. f. Havundersøgelser. Ser. Fiskeri. Bd. VIII Nr. 6, 1928.

Table 1. Number of Plaice caught per hour in the Southern Horns Reef Area, 10—30 m zones (calculated with due regard to the size of the depth-zones). — In brackets: year-classes.

	No. of Stations	I	II	III	IV	V	VI	VII
June 1934	14	309 (1933)	187 (1932)	139 (1931)	121 (1930)	137 (1929)	236 (1928)	3 (1927)
— 1935	14	286 (1934)	290 (1933)	78 (1932)	40 (1931)	20 (1930)	16 (1929)	24 (1928)
— 1936	14	236 (1935)	240 (1934)	94 (1933)	16 (1932)	6 (1931)	0 (1930)	4 (1929)

Table 2 shows the 2-year reduction 1925—27 and 1934—36 for each year-class. It will be noticed that the 1924 year-class was more than 5-doubled from 1925 (as I-Gr.) to 1927 (III-Gr.), agreeing with the fact that the I-Gr. exists mainly at depths of less than 10 m. While at this time of the year the III-Gr. preferably occurs at 10 to 20 m. depths.

Correspondingly, the 1923-class is almost doubled by passing from the II-Gr. stage in 1925 to the IV-Gr.-stage in 1927. 90 % of the plaice which in 1925 belonged to the III-Gr. still remained in 1927 at the V-Gr. stage, a reduction of 10 % by fishing and emigration. Similar causes, but emigration in particular, brought about a reduction to some 12 % of the IV-Gr. of 1925 to 1927 (VI-Gr.).

in growth rate seems to be so small that it can hardly influence either the distribution as to depth-zones or the emigration. The increase in length from one age-group to the next one found from the fishing experiments, however, does not show the growth, especially when considering the enormous reduction of stocks during the later years; but marking experiments made by Dr. TÅNING in 1934 show that the growth of plaice of initial length 25—28 cm. was about 2 cm. only, from April to October of that year.

The intensity of trawling on the nursery-grounds for small plaice and sole is the obvious cause of the enormous reduction. In 1925—27, the Horns Reef area was left to be worked by Danish Fishermen with the saving Danish seine and thereby subject to a size-

Table 2. Percentage of the various year-classes present in the Southern Horns Reef Area after two years.

	From I- to III-Group	From II- to IV-Group	From III- to V-Group	From IV- to VI-Group
From the spring of 1925 to the spring of 1927 (zone 10—20 m.)....	548[1])	185	91	12
From June 1934 to June 1936 (zones 10—30 m.)	30	9	4	0

[1]) This high figure is partly due to the fact that the I-Gr. is badly represented in catches so early in the year at depths of more than 10 m.

Table 3. Percentage of the various year-classes present in the Southern Horns Reef Area after one year.

		From I- to II-Group	From II- to III-Group	From III- to IV-Group	From IV- to V-Group	From V+VI- to VI+VII-Groups
Depth zones 10—30 m.	June 1934—June 1935	94	40	29	17	11
	June 1935—June 1936	84	32	21	15	11
Depth zones 5—30 m.	June 1934—June 1935	74	36	27	17	11
	June 1935—June 1936	111	38	19	14	11

A distinctly different picture is painted by corresponding figures in 1934—1936. The I-Gr. of 1934 is reduced to 30 % as III-Gr. in 1936 (1925/27: 548 %, see footnote to Tab. 2), the II-Gr. to 9 % (as against 185 %), the III-Gr. to 4 % (as against 91 %) whilst the IV-Gr. of 1934 in 1936 as VI-Gr. is practically extinct.

Table 3 shows the 1-year reductions 1934—35 and 1935—36; it will be noticed that these reductions are very similar, that of the latter period slightly greater though than the former one. The number of plaice entering the year as III-group is reduced by 70 % in one year and older plaice are subject to much more serious reductions. The similarity of all reductions calculated in two successive years makes the results obtained seem trustworthy.

This change in reduction of stock, from 1925 to 1936, is hardly due to changes in growth-rate; table 4 shows that the average length of the same age-group has increased slightly in later years but the increase

limit of then 22·5—25·7 cm. — The number of plaice was then reduced by 10 % only from the III-Gr. — to the V-Gr. stages, a percentage which has to-day increased to 95 %.

Table 4. Average length of age-groups II and III in the Southern Horns Reef Area in 1925, 1927 and 1934—1936 (corrected for measurement to the nearest full centimeter below).

	Depth zone m.	II-Group	III-Group
Spring 1925	10—20	13·4	16·8
— 1927	10—20	13·9	19·6
June 1934	5—30	17·2	19·5
— 1935	5—30	14·1	19·7
— 1936	5—30	14·9	18·5

9.

Untersuchungen über die Zusammensetzung der Heringsschwärme in der nördlichen Nordsee 1936.

Von

Dr. Wilhelm Erdmann, Hamburg.

Es ist eine Eigentümlichkeit der nördlichen Fanggründe der Nordsee, dass dort meist von einem Jahr zum andern in der Zusammensetzung der Fänge bedeutsame Veränderungen auftreten. Proben aus diesen Gebieten von zwei aufeinander folgenden Jahren können so grundverschieden sein, dass man daran zweifeln kann, ob die Heringe in beiden Jahren aus denselben Gebieten stammen. In einem besonderen Masse gilt dies für die beiden letzten Jahre 1935 und 1936.

Grundsätzlich ist zunächst zu bemerken, dass Proben aus Fängen mit dem Treibnetz nicht ohne weiteres solchen aus Schleppnetzfängen gleichzusetzen sind. Die Proben aus den beiden Fangarten müssen daher getrennt betrachtet werden.

Die Abb. 1 u. 2 zeigen die Zusammensetzung der Proben nach Alter und Länge der Heringe für 1935 und 1936. Für die Bestimmung des Alters bedienten wir uns der Statolithen und zur Kontrolle z. T. auch der Schuppen. Die Säulen stellen die Altersgruppen, die Kurven die Längengruppen dar. Die gestrichelten Kurven gelten für 1935, die ausgezogenen Kurven für 1936. Die Altersgruppen aus den Proben von 1935 werden durch schmale, gestrichelt umrandete und einheitlich punktierte Säulen, diejenigen aus den Proben von 1936 durch breite, verschiedenartig gekennzeichnete Säulen veranschaulicht. Um einen Vergleich der Befunde aus beiden Jahren zu erleichtern, sind die schmalen Säulen für 1935 derart in die breiten Säulen für 1936 hineingezeichnet worden, dass jeweils die zwei ineinandergezeichneten Säulen für denselben Jahrgang gelten. Die 9 und mehr Jahre alten Tiere sind unter der Bezeichnung 9+ zusammengefasst worden. Gebietsmässig sind die Proben unterschieden in solche, welche aus den Fanggebieten nördlich von 59° N. (Abb. 1 u. 2, a) und solche, welche aus Fängen vom Fladengrund (Abb. 1 u. 2, b) stammen. Die Fanggründe nördlich von 59° N. sind vorerst unter der Sammelbezeichnung "Nördliche Gebiete" zusammengefasst worden. Die Untersuchungen erstrecken sich über die Hauptfangzeit in der nördlichen Nordsee von Ende Juni bis in die zweite Hälfte von August. Insgesamt wurden aus diesen Gebieten rund 4000 Einzeltiere untersucht, von denen 1200 aus Fängen mit dem Treibnetz und rund 2800 aus Fängen mit dem Schleppnetz stammen. Die Abb. 1 gibt die Befunde aus den Schleppnetzproben, die Abb. 2 diejenigen aus den Treibnetzproben wieder. Im Jahre 1935 sind Schleppnetzproben aus den "Nördlichen Gebieten" nicht untersucht worden, sodass ein Vergleich für diese Proben mit 1935 nicht möglich ist.

Betrachten wir die Alterszusammensetzung der Proben, so ist in einem allgemeinen Überblick zunächst festzustellen, dass (1.) die Schleppnetzproben (Abb. 1) eine andere Zusammensetzung als die Treibnetzproben (Abb. 2) zeigen, dass (2.) die Schleppnetz- wie auch die Treibnetzproben aus den "Nördlichen Gebieten" den entsprechenden Proben vom Fladengrund sehr ähneln und dass (3.) die Proben von 1936 völlig anders zusammengesetzt waren als die Proben von 1935. Im einzelnen sind die Proben folgendermassen charakterisiert: — In den Schleppnetzproben von 1936 ist die Altersgruppe 5 als der stärkste Jahrgang dargestellt, doch war er mit 25·5 % in den "Nördlichen Gebieten" und mit 19·2 % auf dem Fladengrund (Übers. 1) nur wenig stärker als die übrigen Gruppen, welche unter sich in fast gleicher Stärke auf die Proben verteilt waren, mit Ausnahme der dreijährigen Tiere. Selbst die über 8 Jahre alten Tiere waren mit 14·2, bzw. 16·5 % in beiden Gebieten gut vertreten. Infolge des hohen Bestandes an älteren Jahrgängen war auch das mittlere Alter aller Tiere mit 5·7 Jahren in den "Nördlichen Gebieten" und mit 6·0 Jahren auf dem Fladengrund hoch (Übers. 1). In den Proben vom Fladengrund hat sich somit das Durchschnittsalter, welches schon im Jahre vorher gegenüber 1934 von 4·9 Jahren auf 5·7 Jahre angestiegen war, abermals erhöht.

In den Treibnetzfängen beherrschten die vier- und fünfjährigen Tiere die Proben, denen gegenüber die übrigen Jahrgänge an Bedeutung sehr gering waren. In den Proben aus den "Nördlichen Gebieten" machten diese beiden Jahrgänge zusammen 86·5 %, in den Proben vom Fladengrund 82·5 % (Übers. 1)

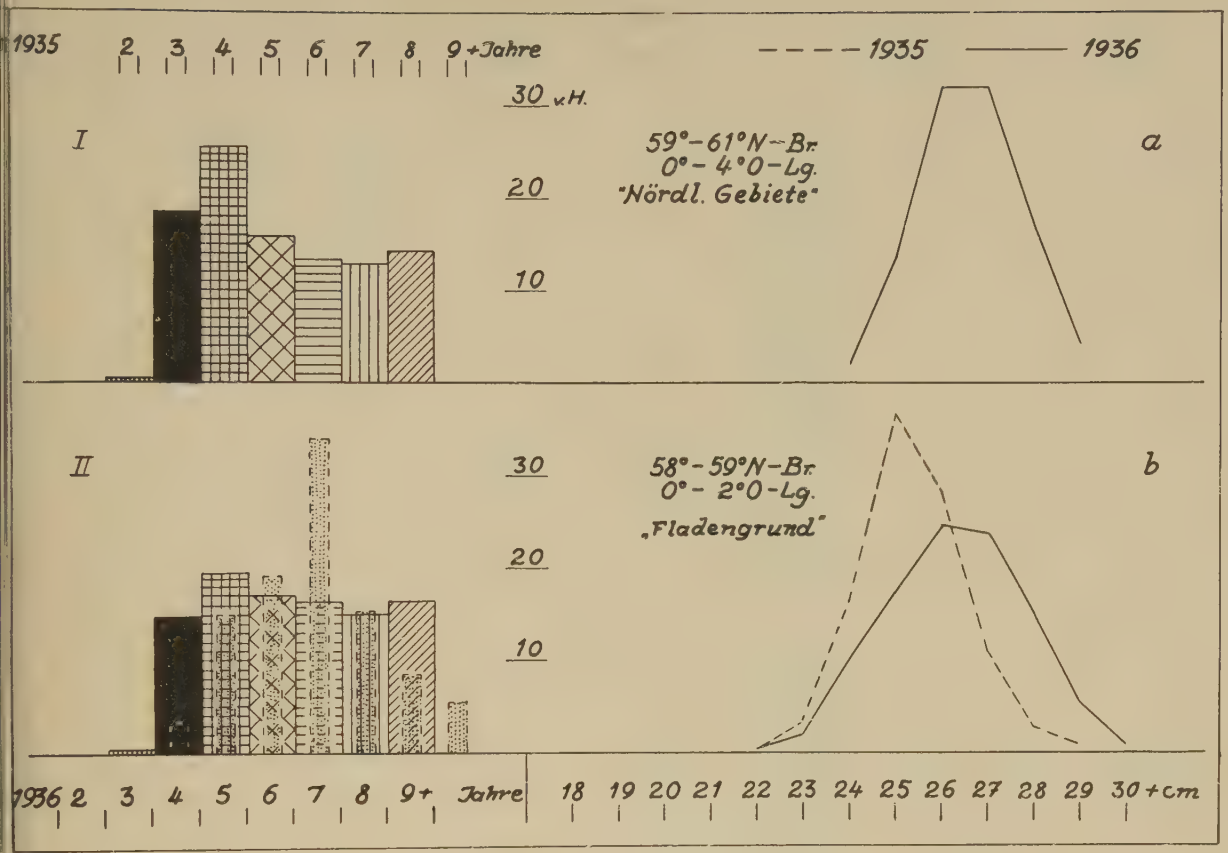


Abb. 1. Alters- und Längengruppen 1935/1936 in den Schleppnetzproben aus der nördlichen Nordsee.
I/a = "Nördliche Gebiete".
II/b = Fladengrund.

Übersicht 1. Altersgruppen.

Alter in Jahren	Schleppnetzfänge. % 1935	Schleppnetzfänge. % 1936	Treibnetzfänge. % 1935	Treibnetzfänge. % 1936
"Nördliche Gebiete."				
3.....	—	0·3	1·5	0·2
4.....	—	18·2	7·4	47·6
5.....	—	25·5	21·2	38·9
6.....	—	15·8	25·0	8·4
7.....	—	13·2	31·6	2·4
8.....	—	12·8	5·9	1·9
9+.....	—	14·2	7·4	0.6
Alter im Mittel[1])	—	5·7	6·0	4·7
Fladengrund.				
3.....	3·3	0·5	—	3·2
4.....	14·9	14·7	8·8	43·4
5.....	19·2	19·5	23·5	38·6
6.....	33·9	17·0	26·0	7·5
7.....	15·2	16·3	26·0	4·7
8.....	8·1	15·5	10·8	1·9
9+.....	5·4	16·5	4·9	0·7
Alter im Mittel[1])	5·7	6·0	6·1	4·7

[1]) Ohne die Altersgruppe 9+.

aus. Der stärkere von den beiden Jahrgängen war in beiden Gebieten die Altersgruppe 4. Die Altersgruppe 6 war mit 8·4 % bezw. 7·5 % vertreten; die übrigen Jahrgänge folgten in gleichmässiger Abstufung. Dreijährige Tiere wurden mit dem Treibnetz auf dem Fladengrund in einer Stärke von 3·2 %, auf den "Nördlichen Gebieten" nur in einer Stärke von 0·2 % gefangen. Ein grosser Teil der dreijährigen Tiere ist sicherlich noch nicht gross genug, um mit dem Treibnetz gefangen werden zu können. Zudem werden sich die jugendlichen, meist noch unreifen dreijährigen Heringe kaum an der Bildung von Laichschwärmen beteiligen. Da aber auch mit dem Schleppnetz nur wenige dreijährige Tiere gefangen worden sind, ein Befund, der mit den Beobachtungen früherer Jahre übereinstimmt, so darf angenommen werden, dass die nördliche Nordsee als Aufwuchsgebiet für junge Heringe von geringer Bedeutung ist. Im Gegensatz hierzu werden dreijährige Heringe z. B. auf dem Dogger regelmässig in stärkerer Anzahl gefangen.

Vergleichen wir die Befunde mit denen von 1935, so bietet sich ein völlig anderes Bild dar. Unter sich

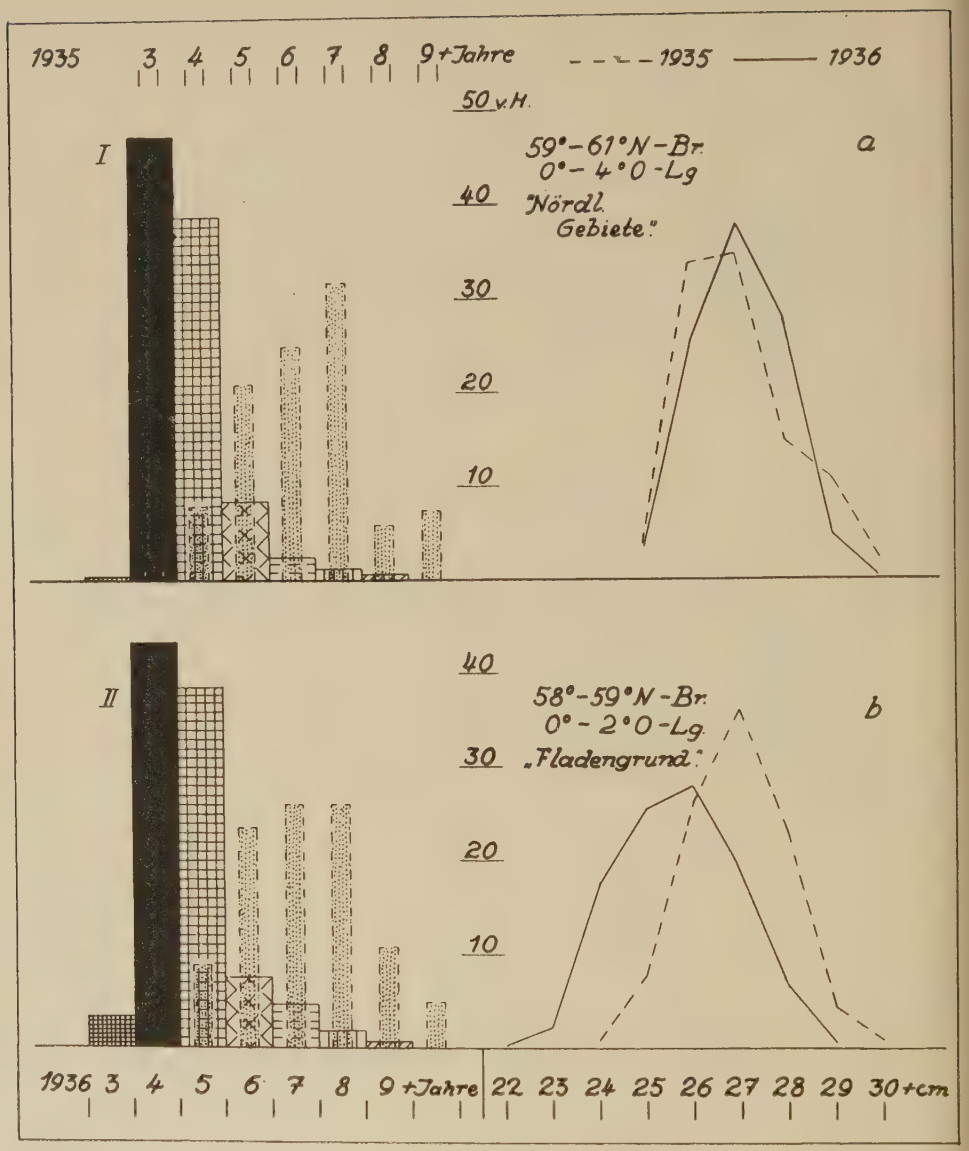


Abb. 2. Alters- und Längengruppen 1935/1936 in den Treibnetzproben aus der nördlichen Nordsee.
I/a = "Nördliche Gebiete".
II/b = Fladengrund.

waren die Treibnetzproben aus beiden Gebieten (Schleppnetzproben fehlen für 1935 aus den "Nördlichen Gebieten") auch im Jahre 1935 nur wenig voneinander verschieden, im Vergleich der beiden Jahre aber stehen sich sowohl die Schleppnetzproben vom Fladengrund als auch die Treibnetzproben aus beiden Gebieten völlig zusammenhangslos gegenüber. In den Schleppnetzproben von 1935 war die Altersgruppe 6 mit fast 34 % als der weitaus stärkste Jahrgang vertreten, dem die Altersgruppe 5 als zweitstärkster Jahrgang mit rund 19 % in weitem Abstand folgte; die übrigen Jahrgänge reihten sich in fast gleichmässiger Abstufung an. Die Treibnetzfänge setzten sich 1935 zur Hauptsache aus den Altersgruppen 5, 6 und 7 zusammen, die in den Fängen aus den nördlichen Gebieten 77·8 %, und in den Fängen vom Fladengrund 75·5 % ausmachten. Am schärfsten tritt also der Gegensatz in der Alterszusammensetzung in den Treibnetzfängen hervor:— Im Durchschnitt waren die Heringe aus diesen Fängen im Jahre 1936 bedeutend jünger als im Jahre 1935; während das Durchschnittsalter aller Tiere im Jahre 1935 bei 6·1 Jahren lag, betrug es im letzten Jahre nur noch 4·7 Jahre.

Wie lassen sich diese Unterschiede erklären? Verständlich machen liesse sich am ehesten noch das Anwachsen der 4. Altersgruppe in den Treibnetzfängen von 1936. Es wäre möglich, dass es sich hier um einen besonders starken Jahrgang handelt, dessen Tiere sich im vergangenen Jahre zum ersten Male

ls Erstlaicher an der Bildung der Laichschwärme eteiligt hätten und so in grösseren Mengen gefangen orden seien. Unverständlich aber bleibt, wo die inf-, sechs- und siebenjährigen Tiere geblieben nd, welche im Jahre vorher in so grossen Mengen n Netz waren. Dass sie weggefangen sein sollten, t wohl kaum anzunehmen.

Betrachten wir die Längengruppen, so scheinen sich ie Verhältnisse zunächst noch verworrener zu estalten. Denn wenn wir soeben feststellten, dass ch die Alterszusammensetzung in den Schleppnetzroben vom Fladengrund und aus den "Nördlichen ebieten" sehr ähnele und dass sie in den Treibnetzroben aus den beiden Gebieten fast völlig gleich sei m mittleren Alter stimmten sie mit 4·7 Jahren berein (Übers. 1)), so zeigt ein Vergleich der Längenruppen (Abb. 1 u. 2 a—b), dass es sich in den verhiedenen Proben nicht um die gleichen Tiere andeln kann, wie auch eine Gegenüberstellung der ittleren Länge aller Tiere der einzelnen Proben eigt (Übers. 2). So steht bei den Schleppnetzfängen

Übersicht 2. Längengruppen.

Länge in cm.	Schleppnetzfänge. % 1935	Schleppnetzfänge. % 1936	Treibnetzfänge. % 1935	Treibnetzfänge. % 1936
"Nördliche Gebiete".				
-23	—	—	—	—
24	—	1·8	—	—
25	—	13·2	4·4	3·8
26	—	31·8	33·8	25·4
27	—	31·8	34·6	38·0
28	—	17·2	14·7	27·6
29	—	4·2	10·3	4·9
30+	—	—	2·2	0·2
ängeimMittel[1])	—	25·3	26·9	27·1
Fladengrund.				
-23	3·3	2·9	—	2·6
24	16·8	9·9	7·0	17·5
25	36·7	17·2	7·8	25·6
26	28·2	24·6	26·4	28·0
27	11·2	23·8	36·4	19·0
28	3·0	15·2	23·0	6·7
29	0·8	5·4	4·4	0·6
30+	—	1·0	1·0	—
inge im Mittel[1])	25·3	26·0	26·9	25·7

[1]) Ohne die Altersgruppe 9+.

ner mittleren Länge von 26·6 cm. und einem ittleren Alter von 5·7 Jahren in den Proben aus n "Nördlichen Gebieten" eine mittlere Länge n 26·0 cm. und ein mittleres Alter von 6·0 Jahren den Proben vom Fladengrund gegenüber. Schärfer ch tritt der Unterschied zwischen den beiden bieten in den Treibnetzproben hervor. Einem eichen mittleren Alter von 4·7 Jahren in den Proben aus beiden Gebieten steht eine mittlere Länge von 27·1 cm. in den Proben aus den "Nördlichen Gebieten" und eine solche von 25·7 cm. in den Proben vom Fladengrund gegenüber. Der Unterschied ist bedeutsam und zeigt, dass sich die Schwärme in den beiden Gebieten aus Komponenten zusammengesetzt haben, deren Tiere ein verschiedenes Wachstum haben. Diese Tatsache weist uns auch auf einen Weg, auf dem wir eine Erklärung über die Zusammensetzung der Heringsschwärme in der nördlichen Nordsee finden.

Als ein grobes Bestimmungsmerkmal für das Alter des Herings ist die Angabe verbreitet, dass der Nordseehering im allgemeinen so alt sei, wie er Zentimeter über 20 messe. — Es soll nicht verschwiegen werden, dass diese Angabe biologischen Nachprüfungen nicht stand hält. — Machen wir uns die Annahme aber vorerst einmal zu eigen, dann kann man sie ausdrücken durch den Begriff: Länge minus 20 gleich Alter, oder einfacher durch die Formel $L - 20 = A$. Dann müsste $(L - 20) - A = 0$ sein. Nun hängt das Wachstum des Individuums von so vielen Faktoren ab, die wohl selten bei allen Tieren der Gemeinschaft dieselben sind, dass diese Formel für das Einzeltier nicht angewandt werden kann. Für eine Unterscheidung von Gemeinschaften in ihrer Gesamtheit aber scheint mir diese Formel wohl geeignet zu sein. Vor allen Dingen dann, wenn wir es mit Tieren mit verschiedener Wachstumsgeschwindigkeit zu tun haben, wie es bei dem sogenannten Bankhering und den nördlichen Frühjahrslaichern der Nordsee der Fall ist, bietet die Formel ein gutes Vergleichsmittel. Da wir hier mit einer Anzahl von Individuen arbeiten, müssen wir die Mittelwerte einfügen, und die Formel würde dann also lauten $(LM - 20) - AM = 0$. (Der Einfachheit halber wollen wir für den Ausdruck $(LM - 20) - AM$ den Buchstaben W einsetzen).

Wenden wir die Formel auf unsere Proben an (Übers. 3), dann erhalten wir für 1936 bei den Schleppnetzproben aus den "Nördlichen Gebieten" für W den Wert + 0·9, bei den Schleppnetzproben vom Fladengrund für W den Wert ± 0·0, bei den Treibnetzproben aus den "Nördlichen Gebieten" für W den Wert + 2·4 und bei den Treibnetzproben vom Fladengrund für W den Wert + 1·0. Gegenüber dem Jahre 1935 ist der Wert bei den Schleppnetzfängen vom Fladengrund um 0·4, bei den Treibnetzfängen vom Fladengrund um 0·2 und bei den Treibnetzfängen aus den "Nördlichen Gebieten" um 1·5 gestiegen. Wollte man die Steigerung der Werte allein auf besonders günstige Wachstumsbedingungen im vergangenen Jahre zurückführen, dann wäre hierzu zu sagen, dass einmal die stärkere Wachstumszunahme z. B. der Heringe aus den Treibnetzproben vom Fladengrund von 1·5 cm. im Mittel aller Tiere im Vergleich zum Jahre vorher eine ausserordentliche Wachstumsgeschwindigkeit anzeige, dass zum andern aber der Unterschied in den einzelnen Proben wenig verständlich wäre. Einen höheren Grund von Wahrscheinlichkeit gewinnt vielmehr von vorn-

Übersicht 3.

		Schleppnetzproben						Treibnetzproben					
		"Nördl. Gebiete"			Fladengrund			"Nördl. Gebiete"			Fladengrund		
		LM[1])	AM[2])	(LM—20) — AM	LM	AM	(LM—20) — AM	LM	AM	(LM—20) — AM	LM	AM	(LM—20) — AM
1934	Alle Tiere ...	—	—	—	24·5	4·9	—0·4	—	—	—	—	—	—
1935	Alle Tiere ...	—	—	—	25·3	5·7	—0·4	26·9	6·0	+0·9	26·9	6·1	+0·8
1936	Alle Tiere.....	26·6	5·7	+0·9	26·0	6·0	±0·0	27·1	4·7	+2·4	25·7	4·7	+1·0
	Herbstlaicher?.	26·3	6·3	*±0·0*	25·9	6·0	*—0·1*	26·6	5·9	*+0·6*	25·1	5·0	*+0·1*
	Frühjahrslaicher	27·1	4·7	**+2·4**	27·2	4·9	**+2·3**	27·1	4·6	**+2·5**	26·4	4·4	**+2·2**

[1]) LM = Länge im Mittel.
[2]) AM = Alter im Mittel.
Die Werte gelten für unter 9 Jahre alte Tiere.

herein die Annahme, dass in den Proben Tiere mit genetisch bedingter verschiedener Wachstumsgeschwindigkeit gemischt waren, und dass die schnellwüchsigen Tiere in den Proben aus den verschiedenen Fängen und Gebieten ungleich stark vertreten waren. Den grössten Anteil an schnellwüchsigen Tieren hätten hiernach die Treibnetzproben aus den "Nördlichen Gebieten" aufzuweisen gehabt, denen die Treibnetzproben vom Fladengrund und die Schleppnetzproben aus den "Nördlichen Gebieten" und die Schleppnetzproben vom Fladengrund in dieser Aufzählung folgten.

Nun wissen wir, dass der Frühjahrslaicher der nördlichen Nordsee (eine oder mehrere Formen) ein solch schnellwüchsiger Hering ist. Und wir folgern, dass sich die Heringsschwärme der nördlichen Nordsee im Jahre 1936 in einem ungleichen Mischungsverhältnis aus Vertretern des schnellwüchsigen, nördlichen Frühjahrslaichers und des weniger rasch wachsenden, herbstlaichenden Nordseeherings zusammensetzten.In Weiterführung dieser Schlussfolgerung ergibt sich dann, dass der Frühjahrshering in der Zeit von Ende Juni bis Ende August in den Treibnetzproben zahlreicher war als in den Schleppnetzproben und, gebietsmässig betrachtet, stärker in den "Nördlichen Gebieten" als auf dem Fladengrund aufgetreten ist.

Von den genannten Heringsgruppen ist uns weiter bekannt, dass sie sich im Mittelwert der Wirbelsummen unterscheiden, und zwar soll dieser Wert für den nördlichen Frühjahrshering bei 57·0, für den Herbstlaicher der Nordsee um einige Zehntel niedriger, etwa bei 56·5 liegen. Ist unsere obige Schlussfolgerung richtig, dann muss sich demgemäss der ungleiche Anteil an Frühjahrslaichern in den einzelnen Fängen auch in einem Vergleich der Mittelwerte für die Wirbelsummen ausdrücken. Und das ist in der Tat auch der Fall, wie die Übersicht 4 zeigt. Entsprechend den Befunden bei der Betrachtung der mittleren Länge im Vergleich zum mittleren Alter ist der Mittelwert für die Wirbelsummen am höchsten in den Treibnetzproben und war, gebietsmässig betrachtet, wiederum in den "Nördlichen Gebieten" höher als in den Proben vom Fladengrund.

Klarer noch als durch die Mittelwerte lassen sich die Verhältnisse durch einen Vergleich der entsprechenden Wirbelpolygone veranschaulichen, wie dies in den Abb. 3—6 geschehen ist.

Übersicht 4. Wirbelsummen 1936.

Wirbel	Schleppnetz-fänge. %	Treibnetz-fänge. %
"Nördliche Gebiete"		
—53.....	—	—
54.....	0·5	—
55.....	3·5	4·0
56.....	36·3	16·3
57.....	48·3	58·2
58.....	11·2	20·9
59+.....	0·2	0·6
Wirbelsumme im Mittel...	56·67	56·98
Fladengrund.		
—53.....	—	—
54.....	0·1	0·1
55.....	4·8	3·0
56.....	43·7	33·5
57.....	45·2	52·2
58.....	5·8	11.1
59+.....	0·4	0·1
Wirbelsumme im Mittel...	56·58	56·72

In der Abb. 3 sind die Wirbelpolygone aller Tiere aus den Schleppnetz- und Treibnetzproben, gebietsmässig zusammengefasst, dargestellt. Am schärfsten unterscheiden sich die Polygone für die Tiere vom Dogger und dem Gat einerseits und für diejenigen aus den "Nördlichen Gebieten" andererseits. Die Gat- und Doggerproben stimmen im Wirbelbild weitgehend überein. Der Gipfelpunkt der Kurven liegt bei 56, eine zweite Spitze bei 57, wodurch das Polygon über dem Abschnitt 55—58 der Abszisse das Bild eines Trapezoids erhält mit einem links liegenden Gipfelpunkt. Das Wirbelpolygon für die Proben aus den "Nördlichen Gebieten" bildet über demselben Bereich einen spitzen Winkel, dessen Gipfel bei 57 liegt. Eine Zwischenstellung nehmen die Proben vom Fladengrund ein, deren Wirbelpolygon über diesem Bereich wiederum ein Trapezoid darstellt, dessen Gipfelpunkt aber im Gegensatz

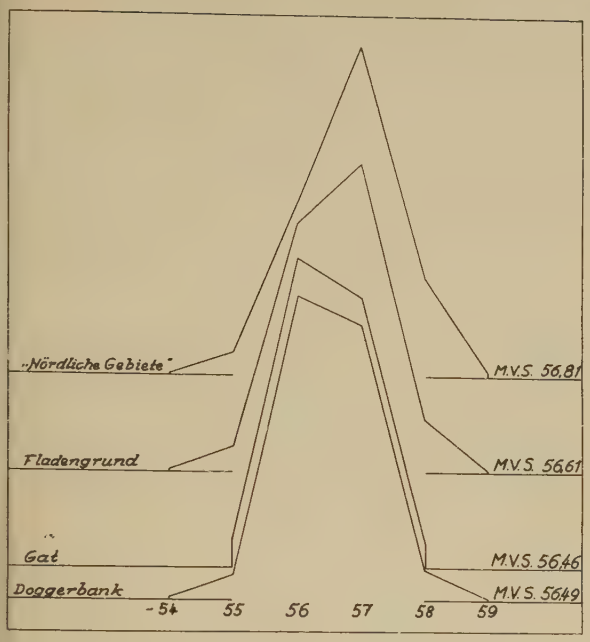


Abb. 3. Prozentuale Häufigkeitskurven des Merkmals Vert. S. aller untersuchten Heringe (Schleppnetz- und Treibnetzproben zusammen).

zu den Proben vom Gat und dem Dogger nach rechts ragt und bei 57 und dessen zweite Spitze bei 56 liegt. Der Prozentsatz der Tiere mit hoher Wirbelsumme ist somit in den Proben aus den "Nördlichen Gebieten" am höchsten, weniger gross in den Proben vom Fladengrund und am niedrigsten in den Proben vom Dogger und vom Gat. In der Abb. 4 sind die Wirbelpolygone der Proben aus der nördlichen Nordsee nach Fangart getrennt wiedergegeben. Den höchsten Prozentsatz an Tieren mit einer hohen Wirbelanzahl lassen die Treibnetzproben erkennen, von denen wiederum die Proben aus den „Nördlichen Gebieten" besonders hervortreten. Es folgen in nachstehender Reihenfolge die Treibnetzproben vom Fladengrund, die Schleppnetzproben aus den "Nördlichen Gebieten" und die Schleppnetzproben vom Fladengrund.

Die Untersuchungen lassen somit den Schluss zu, dass in den Heringsschwärmen der nördlichen Nordsee mindestens zwei Komponenten vorhanden

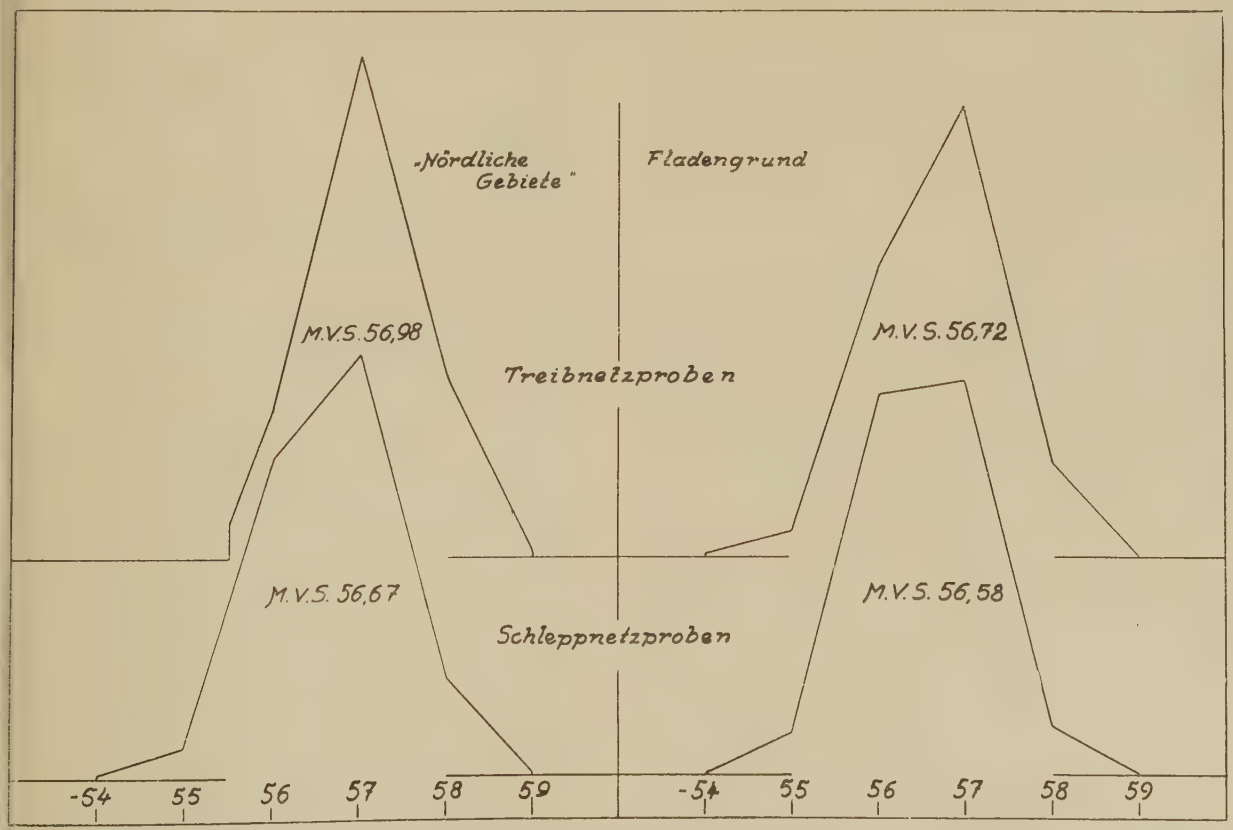


Abb. 4. Prozentuale Häufigkeitskurven des Merkmals Vert. S. in Treibnetz- und Schleppnetzproben aus der nördlichen Nordsee.

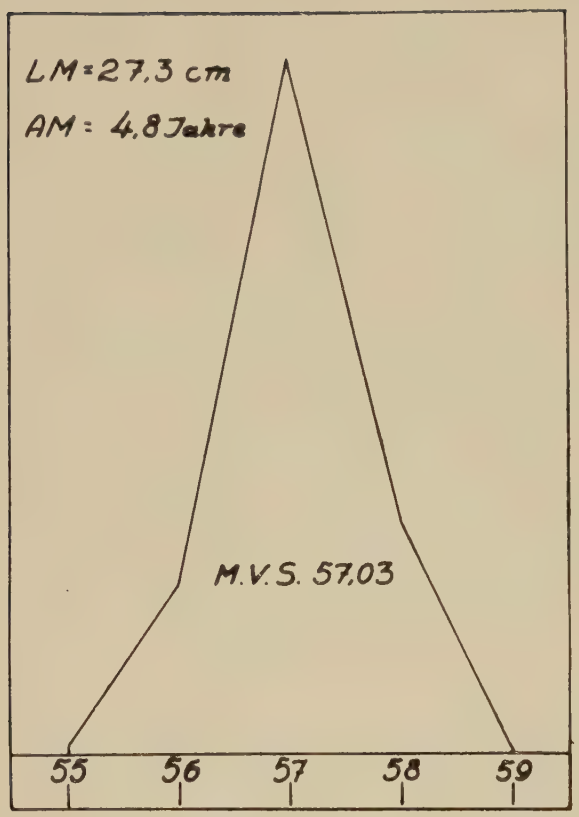


Abb. 5. Prozentuale Häufigkeitskurven von Heringen aus der nördlichen Nordsee mit typisch aufgebautem Statolithen.

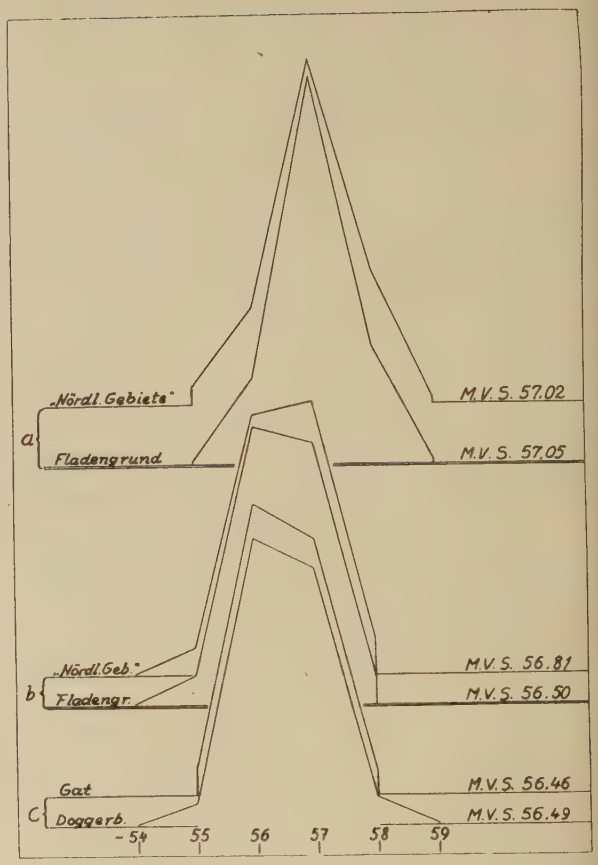


Abb. 6. Prozentuale Häufigkeitskurven des Merkmals Vert. S. a = Frühjahrslaicher in Proben aus der nördl. Nordsee. b = Dieselben Proben ohne die in a dargestellten Tiere. c = Proben in ihrer Gesamtheit.

sind, die sich durch ein ungleiches Wachstum und eine Verschiedenheit der Wirbelpolygone voneinander unterscheiden. Ein grosser Bestand von schnellwüchsigen Tieren ist immer begleitet von einem grossen Bestand an Tieren mit einer hohen Wirbelanzahl. Beide Eigenschaften lassen sich durch alle Proben hindurch verfolgen und sind in den Schleppnetz- und Treibnetzproben einerseits und in den Fängen aus den "Nördlichen Gebieten" und vom Fladengrund andererseits verschieden stark ausgeprägt, immer aber erscheinen beide Eigenschaften gekoppelt in gleicher Abstufung.

Dass es sich bei diesen Merkmalen um typische Eigenschaften nördlicher Frühjahrslaicher handelt, zeigte eine tiefer eindringende Analyse der Proben. Wie weiter oben schon gesagt worden ist, bestimmten wir das Alter der Heringe nach dem Statolithenbild. Unter den Statolithen traten nun solche auf, die sich durch einen eigenartigen Aufbau hervorhoben. In groben Zügen angedeutet, bestand diese Eigenart in einem typischen Umriss des Statolithen und in einer scharfen Abgrenzung der jährlichen Wachstumsringe, welche die Träger dieser Statolithen als zu einer besonderen Gemeinschaft gehörend kennzeichnete. Diese Heringe wurden "blind" aus dem Protokoll herausgezogen, d. h. ohne Rücksicht auf die übrigen Eigenschaften der Individuen. Die angedeuteten Merkmale der Statolithen sind so ausgeprägt, dass es fast in allen Fällen möglich ist, schon an einem Splitter den Typ zu erkennen. Eine weitere Bearbeitung dieser Erscheinung ist im Gange. Eine Prüfung der übrigen Eigenschaften dieser Heringe bestätigte die Vermutung, welche sich schon bei der Betrachtung der Statolithen auf Grund der Ausbildung der Ringe des ersten Lebensjahres der Tiere aufgedrängt hatte, dass es sich um Frühjahrslaicher handelte. Der Reifezustand der Gonaden, welche ohne Ausnahme unreif waren, liess eine andere Deutung nicht zu. Das mittlere Alter dieser Tiere beträgt 4·8 Jahre und die mittlere Länge 27·3 cm. Der Mittelwert der Wirbelanzahl beträgt 57·03, dem das Wirbelpolygon in Abb. 5 entspricht. Der Gipfelpunkt liegt bei 57 und die Kurve fällt nach links und rechts unter Bildung eines spitzen Winkels steil ab. Wir haben hier also eine frühjahrslaichende Heringsgruppe vor uns, welche charakterisiert ist durch ein schnelles Wachstum (Wert W lautet + 2·5), einen hohen

Mittelwert der Wirbelanzahl und durch einen typischen Aufbau des Statolithen.

Eine Durchsicht der Protokolle zeigte, dass auf Grund des Statolithenbildes nicht alle Frühjahrslaicher erfasst worden waren, die an dem Reifezustand der Gonaden aber eindeutig als solche erkannt werden konnten. Es muss gesagt werden, dass es nicht immer leicht ist, allein nach dem Zustand der Gonaden die Zugehörigkeit eines Individuums zur herbst- oder frühjahrslaichenden Gruppe zu bestimmen. Denn einerseits kann man die noch unreifen jugendlichen Heringe oft mit demselben Recht der einen oder anderen Gruppe zuzählen, anderseits aber fehlt eine für alle Rassen gültige Merkmaltafel für die Bestimmung des Reifegrades, weiterhin konnte ich durch meine Untersuchungen feststellen, dass Männchen gewöhnlich schneller reifen als die weiblichen Tiere. Aus all diesen Gründen ergibt sich, dass es zu gewissen Zeiten schwierig ist, die Rassenzugehörigkeit eines Tieres allein auf Grund des Reifezustandes der Gonaden festzulegen.

Doch konnte, wie gesagt, in den besprochenen Proben ausser den durch den Besitz eines typischen Statolithen gekennzeichneten Frühjahrslaichern an dem Reifegrad der Gonaden noch eine zweite frühjahrslaichende Gruppe erkannt werden. Auch die Tiere dieser Gruppe zeichnen sich durch ein schnelles Wachstum und durch eine im Mittel hohe Wirbelanzahl aus. In den beiden hier bildlich dargestellten Merkmalen stimmten die beiden Gruppen der Frühjahrslaicher im grossen und ganzen also überein und wir haben beide in der Abb. 6 a zusammengefasst. Der Mittelwert der Wirbelanzahl lautet für diese Tiere aus den Proben der "Nördlichen Gebiete" 57·02 und für diejenigen aus den Proben vom Fladengrund 57·05. Die Wirbelpolygone in Abb 6 a stimmen mit denen für die Frühjahrslaicher in Abb. 4 überein. Die Abb. 6 b gibt die Wirbelpolygone aller übrigen Tiere aus den entsprechenden Proben wieder. Zum Vergleich zeigt die Abb. 6 c noch einmal die Polygone für alle Tiere aus den Proben vom Gat und vom Dogger. Nach Abzug der Frühjahrslaicher ist das Wirbelpolygon für die Heringe aus den Proben vom Fladengrund dem der Gat- und Doggerheringe sehr ähnlich geworden, wie sich auch der Mittelwert mit 56·50 sehr angenähert hat. Im Gegensatz hierzu zeigen die restlichen Tiere der Proben aus den "Nördlichen Gebieten" ein Wirbelpolygon, das zwar ebenfalls aus einem spitzen Winkel in der Darstellung der Gesamtproben in Abb. 3 über dem Abschnitt 55 bis 58 der Grundlinie zu einem Trapezoid geworden ist, seine Spitze liegt aber bei 57. Vergleichsweise ist hieraus zu entnehmen, dass in dem Rest der Proben noch eine Anzahl Frühjahrslaicher verblieben ist, welche auf Grund des Gonadenzustandes nicht als solche erkannt worden sind. Und wenn wir einen Blick auf die Übersicht 3 zurückwerfen, dann zeigt uns ein Vergleich der Werte für den Begriff (LM — 20) — AM, dass eigentümlicherweise, aber man kann beinahe sagen erwartungsgemäss, auch noch eine Anzahl schnellwüchsiger Tiere vorhanden gewesen ist.

In Angleichung an die getrennte Darstellung der Wirbelpolygone der Frühjahrslaicher und der restlichen Tiere der Proben aus den "Nördlichen Gebieten" und von Fladengrund sind auch das mittlere Alter, die mittlere Länge und der Wert W getrennt errechnet und in den beiden untersten Spalten der Übersicht 3 eingesetzt worden. Die unterste Spalte gibt die Werte für die mit Sicherheit als Frühjahrslaicher bestimmten Tiere wieder. Der Wert für W ist für diese Tiere in allen Proben praktisch gleich und liegt bei + 2·2 bis + 2·5. In der zweituntersten Spalte stehen die Werte für die restlichen Tiere dieser Proben. Auch für diese Heringe ist der Wert W praktisch gleich und liegt bei — 0·1 bis + 0·1 mit Ausnahme der Treibnetzproben aus den "Nördlichen Gebieten", bei welchen der Wert für W bei + 0·6 höher liegt und auf eine Beimischung schnellwüchsiger Tiere schliessen lässt. Diese Proben aber gehören zu jenen, von welchen wir durch das Wirbelpolygon (Abb. 6 b) erfuhren, dass unter dem Rest der Proben noch eine Anzahl Tiere mit einer im Mittel hohen Wirbelanzahl vorhanden sein muss. Also auch hier bestätigt sich das Untersuchungsergebnis, dass bei den Heringen in der nördlichen Nordsee ein höherer Mittelwert für die Wirbelsummen mit dem Merkmal Schnellwüchsigkeit gepaart ist.

Und wie die Abb. 5 und 6 a bewiesen, dass die Frühjahrslaicher der nördlichen Nordsee durch einen hohen Mittelwert für die Wirbelsummen gekennzeichnet sind, so zeigt uns die unterste Spalte der Übersicht 3 vergleichsweise, dass als ein weiteres Merkmal für diese Gruppe oder Gruppen die Schnellwüchsigkeit hinzukommt. Im Verhältnis von Alter zu Länge (Wert W) waren die Frühjahrslaicher in den Proben aus der nördlichen Nordsee im Mittel um rund 2·3 cm. im Wachstum den übrigen Heringen voraus.

Fassen wir die Ergebnisse unserer Untersuchungen zusammen, so können wir folgendes feststellen. In der nördlichen Nordsee werden Angehörige mehrerer Heringsgruppen gefangen. Als Hauptkomponenten können wir in den Fängen eine frühjahrslaichende und eine herbstlaichende Gruppe unterscheiden, die sich von einem Jahr zum andern meist in so unterschiedlichem Masse an der Zusammensetzung der Schwärme beteiligen, dass sich die Alters- und Längengruppen von Jahr zu Jahr grundlegend verändern können. Diese Veränderungen scheinen insbesondere durch die Frühjahrslaicher hervorgerufen zu werden, von denen angenommen werden muss, dass sie sich beim Abzug aus den Laichgebieten von Jahr zu Jahr in verschiedener Stärke auf die Wanderstrassen zerstreuen, beeinflusst wahrscheinlich durch Veränderungen in den hydrographischen und damit planktonischen Verhältnissen.

Eine frühjahrslaichende Gruppe konnte auf Grund eines typischen Statolithenbildes ihrer Angehörigen eindeutig aus den Proben herausgeschält werden. Die Zugehörigkeit des Einzeltieres zu dieser oder jener Gruppe allein auf Grund des Reifezustandes der Gonaden zu bestimmen, lässt sich nicht immer

durchführen, da einmal die Männchen schneller heranreifen als die Weibchen und zum andern der Reifegrad selbst nicht immer einwandfrei zu erkennen ist. Darüber hinaus ist es unmöglich, die noch jugendlichen unreifen Heringe an Hand des Gonadenzustandes einzuordnen. Hierauf ist es auch zurückzuführen, dass, wie die Analyse der Proben ergeben hat, eine zweite, nur auf Grund der Reifebestimmung als Frühjahrslaicher gekennzeichnete Gruppe nicht vollständig erfasst worden ist. Beide Gruppen der Frühjahrslaicher sind charakterisiert durch eine Wirbelanzahl, welche im Mittel über 57 liegt und durch eine, allem Anscheine nach genetisch bedingte Schnellwüchsigkeit.

Um die Wachstumsgeschwindigkeit vergleichsweise zu erkennen, führten wir unter Zuhilfenahme der oft vertretenen Annahme, dass der Nordseehering im allgemeinen so alt sei, wie er Zentimeter über 20 messe, den Begriff ein (LM — 20) — AM = 0, in dem der Ausdruck LM mittlere Länge und AM mittleres Alter bedeutet. Die Formel gibt uns ein brauchbares Mittel zum Vergleich der verschiedenen Heringsgruppen und der aus ihnen zusammengesetzten Schwärme; vor allem lässt sich durch sie eine unterschiedliche Wachstumsgeschwindigkeit schnell erkennen.

Im vergangenen Jahre traten die Frühjahrslaicher in der Zeit von Ende Juni bis Ende August am häufigsten in den Fängen nördlich von 59° N., weniger stark in den Fängen vom Fladengrund auf. Zur Hauptsache hielten sich diese Tiere während der angegebenen Zeit in den oberen Wasserschichten auf und wurden in beiden Gebieten zu einem weit höheren Prozentsatz in den Treibnetzfängen als in den Schleppnetzfängen erbeutet. Der Prozentsatz der einwandfrei als Frühjahrslaicher bestimmten Heringe betrug in den Treibnetzproben aus den "Nördlichen Gebieten" 88·6, in den Treibnetzproben vom Fladengrund 43·9, in den Schleppnetzproben aus den "Nördlichen Gebieten" 32·3 und endlich in den Schleppnetzproben vom Fladengrund 6·2. Aus den angeführten Gründen dürfte der Prozentsatz aber noch etwas höher liegen. Dieser Zusammensetzung der Proben entsprach ein Mittelwert der Wirbelsummen von 56·98, von 56·72, von 56·67 bzw. von 56·58 und ein Wert für W von — 2·4, von — 1·0, von — 0·9 bzw. von ± 0·0 (s. Abb. 4 u. Übers. 3).

10.

Variations of the Surface Temperature at Selvogsbanki, Iceland, during the Years 1895—1936.

By

Helge Thomsen.

Since 1895 the Danish Meteorological Institute has each year in the "Nautical-Meteorological Annual" published observations of surface temperature, collected by vessels crossing the Northern Atlantic. The observations are published in the form of the mean of all observations within 1°-squares: from 1895 to 1911 calculated within time spaces of semi-months, and since 1912 within spaces of months.

All material collected between 1875 and 1915 has been used by Ryder[1]) for calculation of monthly means for each 1°-square.

Fig. 1.

In the present paper the observations from 3 1°-squares a, b, and c, situated between 63°—64° N. Lat., and 23°—22°, 22°—21°, 21°—20° W. Long. respectively are used. These squares have been marked on the chart — Fig. 1 — from which it will be noticed that half the area a and about two thirds of b and c cover waters of less than 200 m. depth. Considering the ordinary routes of the vessels, however, the major part of the material must have been collected within the 200 m. contours.

For each of the squares a, b, and c means have been calculated from the individual semi-monthly means for the period 1895—1911; these 17-year semi-monthly means have been recorded in Table 1. No observations were recorded for the early half of January, but means (in brackets) have been interpolated linearly between the means of the second fortnight of December and January. Semi-monthly means for the area: a + b + c are recorded in column 4, and corresponding monthly means have been calculated — as one half the sum of two semi-monthly means -- and are recorded in the columns 5, 6, 7, and 8, for the areas: a, b, c, and a + b + c, respectively.

For the period 1912—1934, the monthly means have been recorded in Table 2 in a similar way.

From the 17 years monthly means (T_{17}) and the 23 years monthly means (T_{23}), 40 years monthly means have been calculated for the period 1895—1934, from the formula: $T_{40} = (17 \times T_{17} + 23 \times T_{23}) : 40$; these means have been recorded for a, b, c, and a + b + c, in Table 3.

Comparing the annual means for the entire area for 1895—1911 and 1912—1934 (recorded at the bottom of Tables 1 and 2) it will be noticed that the value is 7·3° in both periods, a fact that may be accepted as a criterion as to the reliability of the material. The value 7·3°, however, deviates slightly from that of Ryder (7·5°, Table 4) for 1876—1915. This might indicate that the period 1876—1895, generally, had been warmer than the following 40 years, but very probably the deviation — partly at least — may be due to the fact that sailing vessels, as then used, made observations farther from the coast than the present-day steam- and motor-vessels travelling nearer the coast-line.

In both periods — 1895/1911 and 1912/1934 — we trace an increase of 0·4° from the western 1°-square: a, to the eastern: c: this increase, however, is not the same for all months. In columns 5, 6 and 7 of Table 3, the deviation of the 40-year monthly means of the

[1]) C. Ryder: Monthly Mean Temperatures of the Surface Water in the Atlantic, North of 50° N. Lat. Appendix to the Nautical Meteorological Annual. København 1917.

Table 1. Mean temperatures 1895—1911.

	1	2	3	4	5	6	7	8
	a	b	c	(a+b+c):3	a	b	c	(a+b+c):3
I	(5·3)	(5·3)	(5·6)	(5·4)	5·2	5·4	5·8	5·5
	5·2	5·4	6·0	5·5				
II	4·6	5·5	5·4	5·2	4·2	5·0	5·0	4·7
	3·8	4·6	4·6	4·3				
III	4·0	5·0	5·3	4·8	4·6	5·2	5·5	5·1
	5·1	5·5	5·7	5·4				
IV	5·2	5·9	6·4	5·8	5·6	6·0	6·4	6·0
	6·0	6·2	6·5	6·2				
V	6·5	6·5	6·8	6·6	6·8	7·0	7·2	7·0
	7·1	7·4	7·5	7·3				
VI	8·3	8·4	8·6	8·4	8·8	8·9	9·0	8·9
	9·4	9·4	9·3	9·4				
VII	10·3	10·6	10·5	10·5	10·6	10·7	10·6	10·6
	10·9	10·8	10·8	10·8				
VIII	10·8	11·0	11·0	10·9	10·7	10·8	10·8	10·8
	10·6	10·7	10·6	10·6				
IX	9·9	10·1	9·8	9·9	9·5	9·6	9·5	9·5
	9·2	9·1	9·2	9·2				
X	8·2	8·6	8·1	8·3	7·8	8·0	7·8	7·9
	7·3	7·5	7·5	7·4				
XI	6·6	6·6	6·7	6·6	6·2	6·5	6·8	6·5
	5·9	6·4	6·9	6·4				
XII	5·3	5·9	6·3	5·8	5·4	5·6	5·8	5·6
	5·5	5·2	5·3	5·3				
Year	7·12	7·40	7·52	7·33				

Table 2. Mean temperatures 1912—1934.

	1	2	3	4
	a	b	c	(a+b+c):3
I	4·8	5·0	5·6	5·1
II	4·9	5·4	5·7	5·3
III	4·9	5·3	5·7	5·3
IV	5·4	5·5	5·7	5·5
V	7·0	7·1	7·3	7·1
VI	8·8	9·1	9·1	9·0
VII	10·4	10·8	10·8	10·7
VIII	10·8	10·9	10·9	10·9
IX	9·2	9·2	9·4	9·3
X	7·7	7·6	7·6	7·6
XI	5·8	6·2	6·3	6·1
XII	5·0	5·0	5·8	5·3
Year	7·06	7·26	7·49	7·27

Table 4. Mean temperatures 1876—1915 after Ryder.

	1	2	3	4
	a	b	c	(a+b+c):3
I	4·8	5·8	5·8	5·5
II	4·4	5·1	5·2	4·9
III	5·0	5·6	6·1	5·6
IV	6·1	6·5	6·8	6·5
V	7·0	7·3	7·4	7·2
VI	8·7	9·0	9·0	8·9
VII	10·8	10·7	10·6	10·7
VIII	10·9	10·8	10·8	10·8
IX	9·6	9·9	9·9	9·8
X	8·1	8·4	8·3	8·3
XI	6·3	6·4	6·9	6·5
XII	5·5	5·8	5·8	5·7
Year	7·27	7·61	7·72	7·53

Table 3. Mean temperatures 1895—1934.

	1	2	3	4	5	6	7	8	9	10
	a	b	c	(a+b+c):3	a	b	c	a	b	c
I	4·97	5·17	5·68	5·27	—30	—10	41	—34	—3	37
II	4·60	5·23	5·40	5·08	—48	15	32	—41	3	38
III	4·77	5·26	5·62	5·22	—45	4	40	—40	7	32
III	5·48	5·77	6·00	5·75	—27	2	25	—29	1	28
V	6·92	7·06	7·26	7·08	—16	— 2	18	—20	2	18
VI	8·80	9·02	9·06	8·96	—16	6	10	—16	5	12
VII	10·48	10·76	10·72	10·65	—17	11	7	—13	7	7
VIII	10·76	10·86	10·86	10·83	— 7	3	3	—10	4	5
IX	9·33	9·37	9·44	9·38	— 5	— 1	6	— 4	2	1
X	7·74	7·77	7·68	7·73	1	4	—5	—11	3	8
XI	5·97	6·33	6·51	6·27	—30	6	24	—16	—2	19
XII	5·17	5·26	5·80	5·41	—24	—15	39	—26	—6	35
Year...	7·08	7·32	7·50	7·30						

individual 1°-squares from those of the entire area have been recorded in hundred-parts of degrees. It is seen from the table that the increase of temperature — going east — is highest in winter and lowest in summer. Columns 8, 9 and 10 record smoothed values of deviations, calculated from overlapping 3-month means.

Based on the 40 years' monthly mean temperature (Table 3, Column 4 and graphically shown in Fig. 2), temperature differences have been calculated for each of the months for which observations are recorded in one or more of the three squares. Where observations exist from all three squares the mean temperature of the month has been calculated as one third the sum of the values; where observations are recorded for 1 or 2 squares only, the mean has been improved by means of the figures of columns 8, 9 and 10 of Table 3.

For the period 1895—1911 in which observations are published as semi-monthly means, the 40-year semi-monthly means have been derived from the curve of Fig. 2. The temperature deviation was determined for each semi-month, and the semi-monthly deviations recalculated as monthly deviations from mean-temperature.

The table shows that the temperature deviation from the 40-year's mean do not run regularly month by month as could have been expected if the single monthly means had been fully representative of the average temperature of the entire water body within the area under discussion. In order to eliminate single great deviations a smoothing was made by calculation of overlapping means of 3 consecutive monthly deviations. The smoothed monthly deviations, thus obtained, are shown in Fig. 3, where black columns represent positive deviations, hatched ones: negative deviations.

Table 5 shows for each year the average deviation of the temperature from the 40-year's mean. The standard deviation of annual means from the 40-year's mean amounts to 0·418° for the period 1895—1934; years showing a deviation of more than 0·42°, therefore,

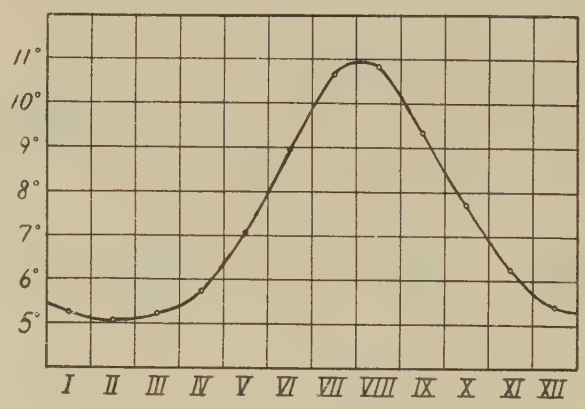


Fig. 2. Temperature cycle of the surface water, Selvogsbanki. Mean of the years 1895—1934.

may be considered definitely cold or warm, according to sign. Thus, the years 1907, 1914, 1915, 1919, 1921, 1922, and 1923 may be defined definitely cold ones, while 1895, 1904, 1928, 1929, 1933, 1934, 1935, and 1936 may be defined definitely warm ones.

It is very striking that the period 1895—1912 contains three abnormal years only, while cold and warm years otherwise change; the period 1913—1925 on the other hand seems cold, 6 years definitely cold even, while the period 1926—1936 has been warm, 6 of the years definitely warm.

The progression of annual deviations has been examined as to possible periodic variations of 2·5, 3, 3·5, 4, 5, and 6 years, but no result is definite enough to confirm the presence of any such regularity.

It may be superfluous to add that the present contribution rests on a somewhat vague material; if it had been based on serial observations at fixed stations within the area the importance of such contribution would have carried far greater weight, but such observations do not exist to such extent, that they as yet can be of use to a similar examination.

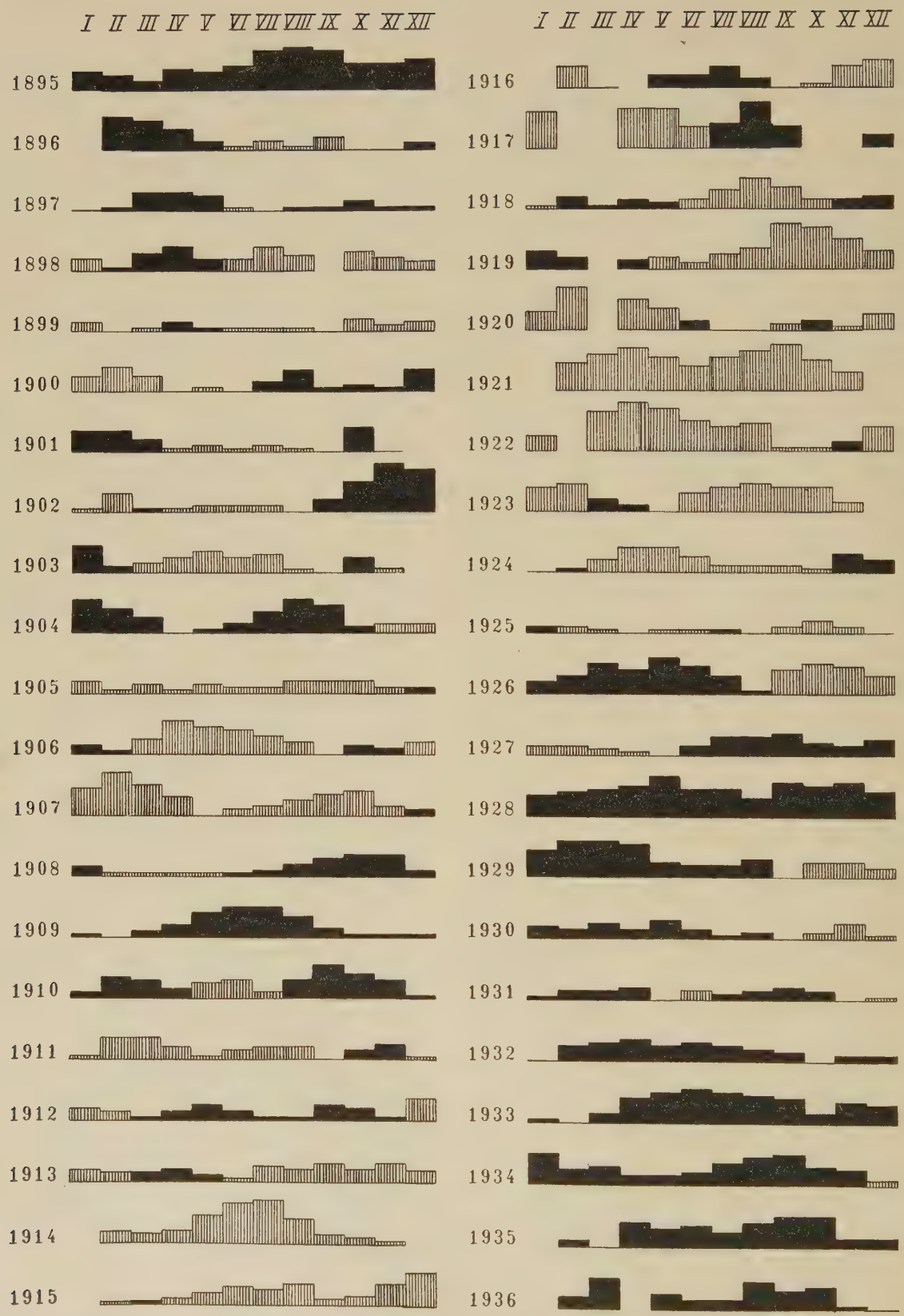


Fig. 3. Smoothed deviations from the mean temperature. Positive deviations: black, negative deviations: hatched. The distance between the basis lines of two successive years represents a deviation of 2·0°.

Table 5. Deviation of the temperature from the 40-year mean temperature.
Area: a + b + c.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
1895	1·2	—0·7	1·0	0·5	0·5	0·8	1·2	1·8	1·2	0·8	0·7	1·1	**0·84**
1896	—	1·2	0·9	0·9	0·2	—0·2	—0·2	—0·6	0·4	—1·0	0·7	0·3	0·24
1897	—0·3	0·1	0·4	1·4	0·0	0·0	—0·2	0·3	0·3	—0·2	0·8	—0·3	0·19
1898	—0·3	—0·5	1·0	1·4	0·0	—0·2	—1·0	—1·1	—	0·6	—1·2	—0·5	—0·16
1899	0·7	—1·2	0·6	0·2	0·1	0·1	—0·4	0·1	0·0	—0·2	—1·0	0·6	—0·03
1900	—0·4	—1·8	—0·1	0·3	—0·2	—0·3	0·6	0·7	0·7	—1·2	1·0	0·5	—0·02
1901	0·5	1·0	0·5	—0·3	—0·4	0·0	0·2	—0·8	0·4	0·5	1·5	—	0·28
1902	—2·1	0·4	—0·1	—0·1	—0·2	—0·2	—0·1	—0·2	0·2	1·3	1·4	2·1	0·20
1903	0·8	—0·1	0·0	—0·8	—0·7	—0·7	0·0	—1·0	0·6	0·4	0·4	—	—0·10
1904	1·5	1·4	—0·4	0·4	0·0	0·0	0·8	1·4	1·0	0·3	—0·6	—0·6	**0·43**
1905	0·2	—0·8	0·2	—0·2	—0·4	—0·2	—0·1	—0·2	—0·8	—0·1	—0·2	—0·2	—0·23
1906	1·0	0·1	—0·8	—0·9	—1·7	—0·2	—0·6	—0·9	0·2	0·8	—0·1	—0·1	—0·27
1907	—1·1	—1·4	—1·8	0·2	—0·1	0·0	—0·6	—0·4	—0·6	—1·2	—0·5	0·8	**—0·56**
1908	0·3	—0·2	—0·4	0·2	0·0	—0·5	0·8	0·2	0·1	1·6	0·4	0·0	0·21
1909	0·2	0·1	—0·4	0·8	0·7	0·8	1·6	0·6	—0·2	0·4	0·2	—0·4	0·37
1910	0·4	0·6	1·0	0·2	—0·2	—1·4	—0·1	0·8	1·2	1·4	—0·2	0·5	0·35
1911	0·0	—0·9	—1·3	0·1	—0·1	—0·4	—0·5	—0·2	—0·5	0·8	0·5	0·2	—0·19
1912	—1·1	—0·2	0·3	0·1	0·6	0·8	—0·4	0·0	0·6	1·0	—0·5	—0·3	0·08
1913	—1·2	0·4	—0·1	0·7	0·6	—0·7	—0·3	—0·4	—0·6	—0·9	0·2	—1·0	—0·28
1914	—	—0·4	0·1	—0·7	—0·5	—1·6	—1·9	—0·6	0·1	—0·4	—0·4	—	**—0·63**
1915	—	0·5	—0·3	0·2	—0·5	—0·8	—0·5	—0·3	—1·3	1·0	—0·7	—2·3	**—0·45**
1916	—	—0·3	0·5	—	—0·2	0·8	0·7	0·7	—0·5	—0·1	0·2	—2·3	—0·05
1917	—0·6	—	—	—0·7	—2·5	—0·7	1·2	2·0	1·3	—	—	—1·3	—0·16
1918	1·3	—0·4	0·3	0·4	0·3	—0·2	—0·9	—0·6	—1·6	0·0	0·8	0·0	—0·05
1919	0·4	1·3	—	—0·5	0·0	—0·6	—0·1	—0·9	—1·2	—2·3	—0·7	0·0	**—0·42**
1920	—1·0	—0·7	—	—2·6	0·2	0·2	0·5	—0·7	0·1	1·1	—0·4	—1·0	—0·39
1921	—	—0·1	—1·7	—1·8	—0·8	—0·8	—0·8	—1·6	—1·4	—1·5	—0·2	—	**—1·07**
1922	—0·2	—	—1·1	—2·7	—0·9	—0·6	—1·6	—0·3	—0·7	0·6	—0·1	0·4	**—0·65**
1923	—2·6	—0·1	0·0	1·1	—0·5	—0·6	—0·6	—1·1	—1·1	—0·3	—1·0	—	**—0·62**
1924	0·4	0·6	—0·8	—1·0	—0·7	—0·6	—0·1	0·0	—0·5	0·0	0·2	1·5	—0·08
1925	—0·5	—0·4	0·2	—0·2	0·0	—0·1	—0·2	0·7	—0·5	—0·7	0·0	0·0	—0·14
1926	0·1	1·2	0·4	1·5	0·6	1·4	0·6	—0·1	—0·3	—2·1	—0·7	0·0	0·22
1927	—1·2	0·2	0·0	—0·7	0·3	0·3	0·4	1·0	0·4	0·7	0·1	0·2	0·14
1928	1·1	0·7	0·5	1·5	0·9	1·4	0·5	0·9	0·4	2·0	0·5	0·8	**0·93**
1929	1·2	0·8	1·6	1·2	0·6	—0·4	1·0	0·7	0·0	—0·7	—0·9	0·1	**0·43**
1930	—0·1	1·2	—0·3	0·5	0·6	0·6	—0·4	0·0	0·9	—0·8	—0·6	—0·1	0·12
1931	0·4	0·0	0·4	0·6	0·2	—0·8	—0·4	0·6	0·8	—0·2	0·4	—0·3	0·14
1932	—0·3	0·5	1·3	—0·1	1·0	0·5	0·3	0·8	0·1	—0·1	—0·1	0·8	0·39
1933	—0·1	—0·4	0·6	0·7	1·2	1·0	1·1	1·0	0·7	0·7	—0·4	1·8	**0·66**
1934	0·5	0·8	0·3	0·6	0·0	0·2	0·9	0·8	0·9	1·4	—0·4	0·5	**0·54**
1935	—	—0·8	0·9	0·0	1·4	0·4	0·3	0·9	1·2	0·9	0·9	—0·9	**0·47**
1936	—	1·0	1·2	—	0·7	—0·5	0·8	0·6	1·2	—0·1	1·0	—0·5	**0·54**

11.

New Oceanographic Investigations in the Northern North Sea.

By

Jens Eggvin,
Fiskeridirektoratet, Bergen.

Based on the Salinity-distribution of surface water G. Böhnecke[1]) has constructed charts of surface currents in the North Sea. At the end the author reproduced two charts showing, schematically, the surface currents in February and August, and generally speaking, the features of these charts are very alike. A comparison with John B. Tait's[2]) charts of surface currents based on drift-bottle experiments shows a good agreement, particularly in respect of the southern part.

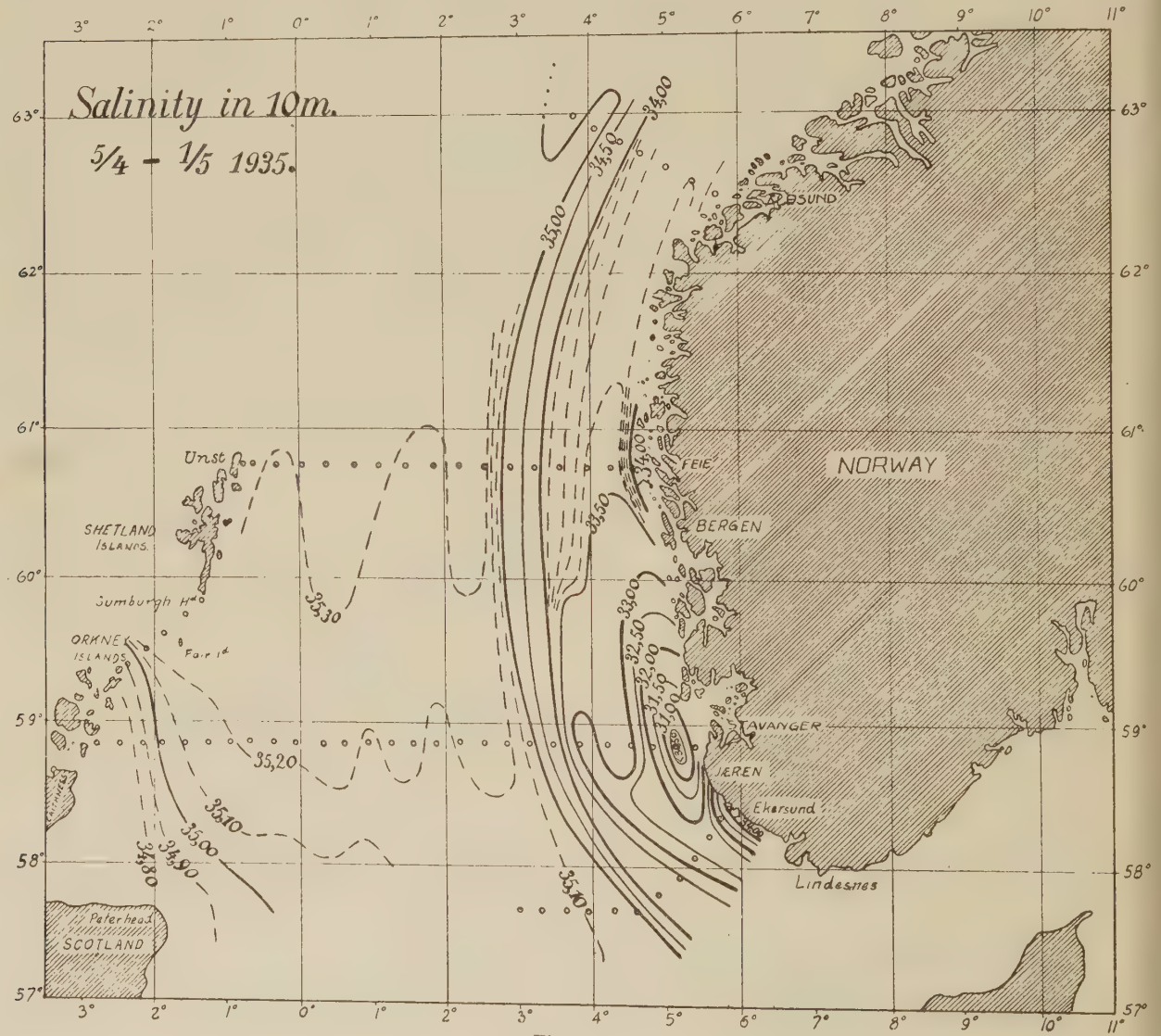


Figure 1.

The northern part of the North Sea being subject to an important fishery, for herring specially, it will be very important, from a fishing point of view, to extend as far as possible our knowledge on movement and exchange of water in deeper layers also and over the widest possible area. We may expect to find variations in the direction of currents at different depths especially where different types of water are present and where depths are great such as in the Norwegian Deep. From current-measurements outside Jären in 1906 HELLAND-HANSEN[3]) concludes: "In the upper layers down to a depth of about 100 meters there is a fairly strong resulting stream from the South (SW-SE) to North, and there is a weak stream near the bottom going in a contrary direction." But also on the more shallow eastern North Sea plateau the surface current direction may differ from that of deeper layers in years when the North Sea water, resting on the Atlantic water below, is widely distri-

[1]) BÖHNECKE, G.: Salzgehalt und Strömungen der Nordsee. Veröff. der Inst. f. Meereskunde (N. F.) A. H. 10. Berlin 1922.

[2]) TAIT, JOHN B.: Surface Drift-Bottle Results in Relation to Temperature, Salinity and Density Distributions in the Northern North Sea. Rapports et Procès-Verbaux des Reunions Vol. LXXXIX No. 8. Copenhague 1934.

[3]) HELLAND-HANSEN, B.: Current-Measurements in Norwegian Fjords, the Norwegian Sea and the North Sea in 1906 (p. 28). Bergens Museums Årbok 1907. Bergen 1908.

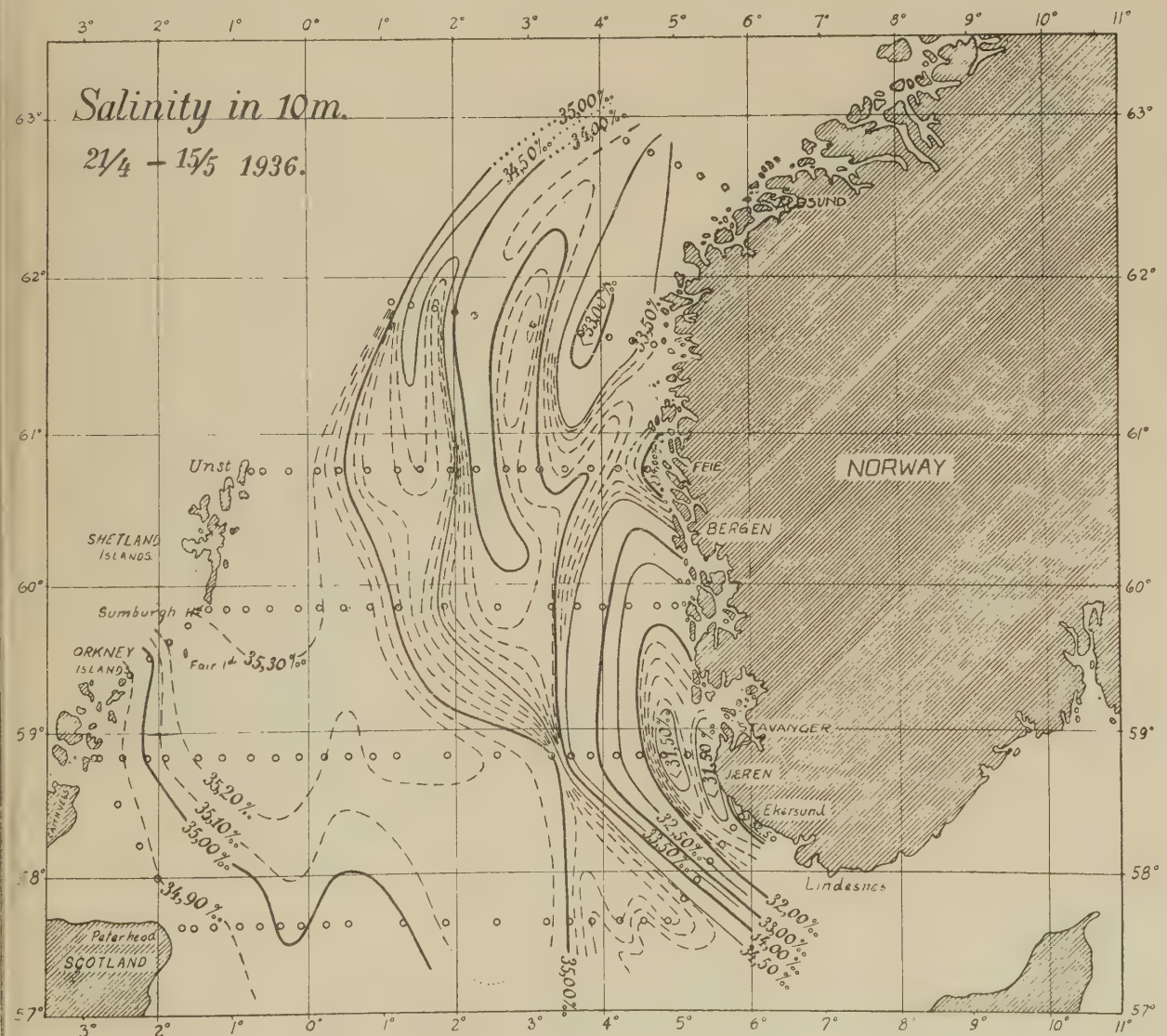


Figure 2.

buted. This happened in the spring of 1936, while in the spring of 1935 the North Sea water did not reach far afield, Atlantic water reaching the surface on the northern North Sea plateau.

An important step towards better knowledge on currents in the northern North Sea could be obtained from a net of closely placed hydrographical stations with observations at all standard depths from surface to bottom and from coast to coast, made within the shortest possible time. Until recently no such material has been available.

In the spring, 1936, the Fishery Directorate of Bergen hired the M/S "Armauer Hansen" from the "Bergen Museum" and made extensive hydrographic and biologic investigations within the northern North Sea, from Lindesnes to Peter Head, in south, and from Shetland to Feie, in Norway, going north to Møre. Observations at Møre were made from the M/S "Johan Hjort". A total of 770 temperature and salinity observations were made at 103 stations, in addition: 286 determinations of O_2, 277 on pH and 90 plankton hauls were made. From Fig. 2, it will be noticed that sections were placed along each degree of latitude and across the waters between Shetland, Orkney and Peter Head.

The distance between two stations has generally been 10 nautical miles, exceptionally 20 miles, and in the western part, across the Norwegian Deep,

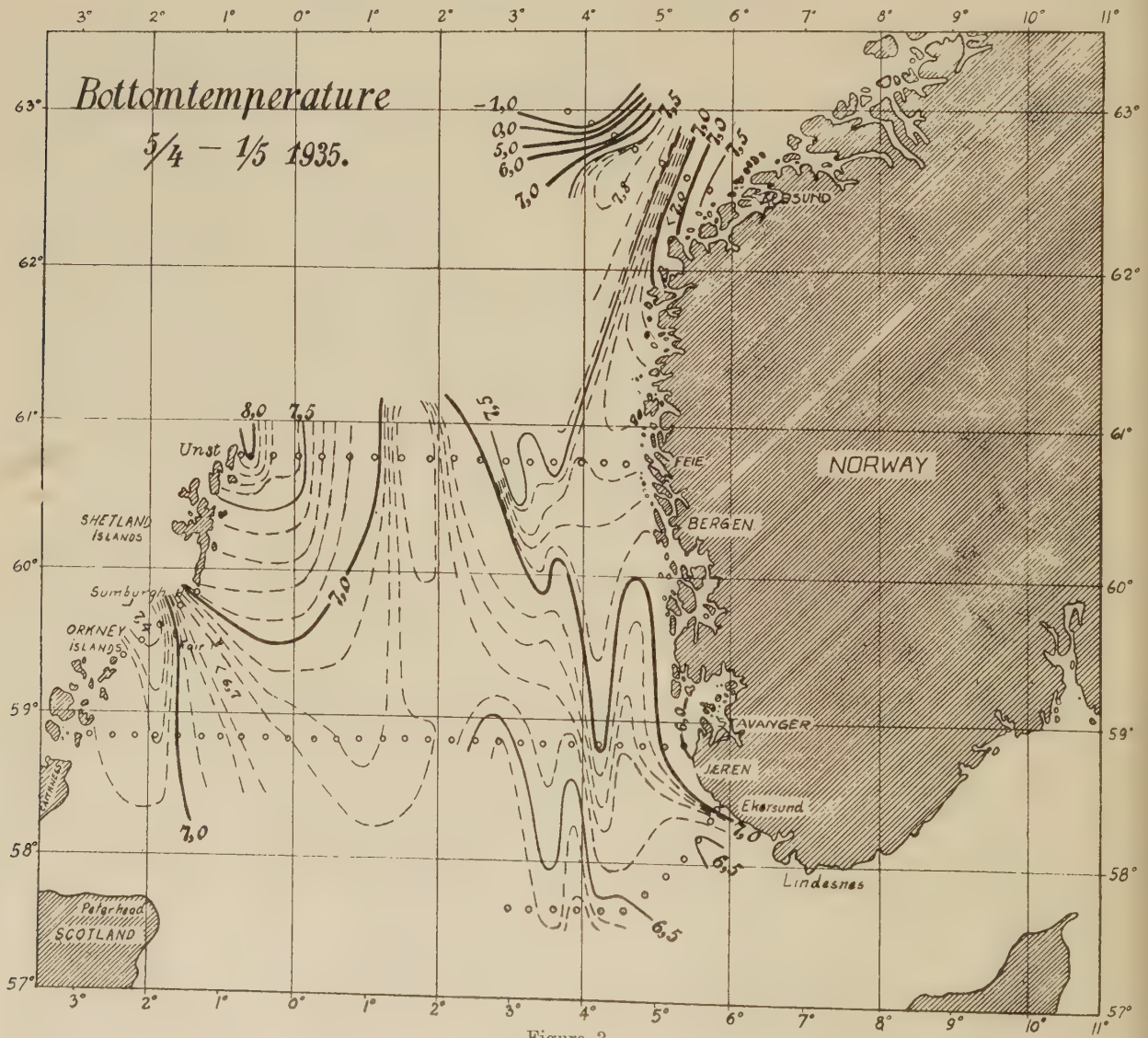


Figure 3.

7—8 miles only. In Fig. 2 stations are indicated by open circles.

With the exception of the northernmost section made on May 14th—15th, the programme was completed within 18 days, from April 20th to May 8th. The time interval between stations thus being short, the observations are of great importance to the hydrodynamic valuation of the material. A similar programme was carried through during spring, 1937.

These investigations are continuations and extensions of similar work begun by the Directorate in the spring of 1935 and repeated in September of the same year.

Through the Investigation Fund of the Fishery Industries Dr. S. Runnstrøm secured the economic foundation of the cruises and the programme was prepared by him in collaboration with Mr. J. Eggvin; Dr. Runnstrøm has kindly placed the hydrographical material at the author's disposal for further treatment.

On several occasions Helland-Hansen has stressed the importance of placing stations as close as possible; this has been strongly confirmed by the examination of the present material. Important details for understanding exchange of water-masses would have been lost if the net of stations had been more open. Very probably, not only details but main features also would have been better defined, still, if stations had been more closely placed.

Comparing hydrographical conditions in the North

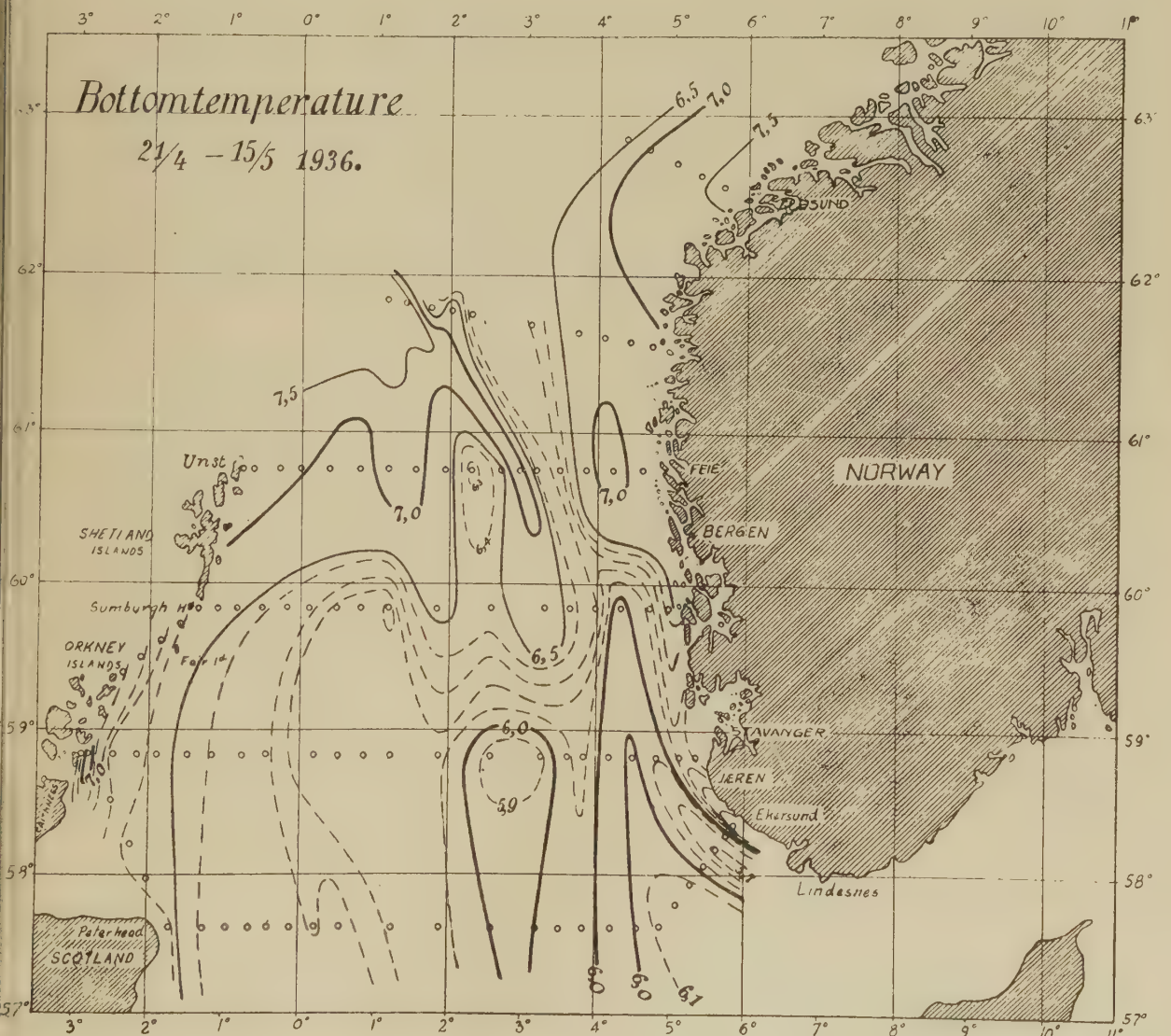


Figure 4.

Sea during the springs of 1935 and 1936, a marked difference will be noticed in temperatures as also salinities differ. In 1935, Atlantic water (e.g. water of more than 35 $^0/_{00}$ salinity) penetrated farther into the North Sea than in 1936; a distribution very noticeable in the upper 50 m. layer, north of 59° N. Lat. Salinities of 10 m. depth during spring 1935 and 1936 are recorded in Figs. 1 and 2, from which it will be noticed that the Belt of Atlantic water, in 1935, was some 196 km. wide along the Feie—Balta section, i. e., reaching from Shetland almost to the 3° E. Long. This distribution may be considered about normal at 10 m. depth. In 1936, however, Atlantic water reached no more than 82 km. east of Shetland; south of 59° N. Lat. there is no marked difference noticeable throughout the two years.

At 75 m. depth the Atlantic water-belt was 46 km. wider in 1935 than in 1936, whilst south of 59° N. Lat. conditions are similar in the two years.

At the bottom the difference in salinity between the two seasons is hardly noticeable, although 35.30 $^0/_{00}$ reaches slightly farther east in 1935.

In the upper 50 m., water of salinity lower than 35 $^0/_{00}$ was widely distributed in 1936 and caused an extensive formation of whirls. Half degree isohalines (full-drawn lines) and tenths of degree isohalines (broken lines) in Fig. 2 indicate an extensive system of whirls between Bergen and Ålesund westwards to the 1° E. Long. Further, the isohalines of Figs. 1 and 2 show a well developed whirl between Bergen and Jären in 1935 as well as 1936.

In the above-mentioned work by G. Böhnecke, the author points out that a whirl exists during May off the Norwegian Stavanger coast. This whirl occurs in the boundary between Atlantic and coastal waters. The author is of opinion that it is caused by increased supplies of coastal freshwater forcing the coastal current seawards. Closely studying Fig. 2, it will be noticed that a similar whirl is indicated near the 3° E. Long., off Jären, just on the boundary between Atlantic and North Sea waters. The figure clearly illustrates that the former whirl between Jären and Bergen, most strongly developed off Boknfjord (Stavanger), is quite different in character from the latter; it is situated nearer the coast and within the coastal water; its direction, further, is clock-wise, contrary to that of the other whirl. It must be differently formed, viz., as a reactionary eddy.

Bottom-temperatures differ considerably during the two years; north of Shetland the temperature is as much as 1° lower in 1936, than 1935. The 1936 bottom temperature was generally 0·5 to 1° lower than the 1935 one in the northern part of the North Sea. In 1935, bottom temperatures of less than 6·5° C. were very limited south of 59° N. Lat. (Fig. 3), in 1936, however, the major part of the northern North Sea plateau was covered by water colder than 6·5° (Fig. 4); certain parts west of southern Norway even show temperatures below 6°. During April, 1935, bottom temperatures varied between 8·04° and 6·37°, in 1936 between 7·32° and 5·69°.

Along the section: Feie—Unst the bottom temperatures in spring, 1937, were somewhat lower than corresponding temperatures, in 1936, along a line: Unst to the W-shelf of the Norwegian Deep (about 3° E.). Differences recorded reach 1·7° but average 0·7°. At the bottom of the Norwegian Deep no difference in temperature is worth recording.

Similar conditions occurred along the section: Jären—Water Sound, viz., 1937 spring temperatures were lower than the year before. Difference here average about 0·5°, but reach at several localities as much as 1·2°. Difference in bottom temperatures in the Norwegian Deep were minimal.

The greatest differences are recorded along the section: Egersund—Peter Head. Between Peter Head and the longitude 3° E. the difference in temperature of April 1937 from April 1936 was minus 0·6 to 0·8° whilst greater differences of 1·1° to 1·7° were recorded between 2° E. and 5°30′ E. Bottom temperatures on the Norwegian Deep also were somewhat lower in 1937.

It appears that bottom temperatures in the entire northern North Sea were lower — in some localities considerably lower — in April 1937 as compared to the previous year. A decline of temperature from April 1935 to April 1936 has been recorded previously, this development continued until April 1937. Bottom temperatures of 1935 along the Feie—Unst varied between 6·51° and 8·04°, in 1937 they ranged from 5·40° and 7·35°. Corresponding temperature limits along the Egersund-section to 3° E. were 6·29—7·05° (1935) and 4·33—5·58° in 1937.

Table 1 shows mean temperatures at bottom for various sections in 1935, 1936, and 1937, respectively, and specified for the Norwegian Deep and the North Sea plateau. From this it will be observed that the decline is greatest in the southern part of the area under discussion, for obvious reasons the greatest decrease is recorded on the plateau.

Lower temperatures of Atlantic water in the North Sea is no isolated case, in other localities also decreas-

Table 1.

Section	Entire section			North Sea plateau			Norwegian Deep		
	1935	1936	1937	1935	1936	1937	1935	1936	1937
Feie—Unst	7·32	6·85	6·51	7·26	6·89	6·26	7·46	6·78	7·00
Slotteröy—Sumburg Head	—	6·40	6·11	—	6·40	5·82	—	6·39	6·55
Jären—Water Sound	6·77	6·21	5·64	6·80	6·30	5·66	6·69	6·02	5·90
Egersund—Peter Head	—	6·18	5·26	—	6·22	5·25	6·67	5·98	5·33

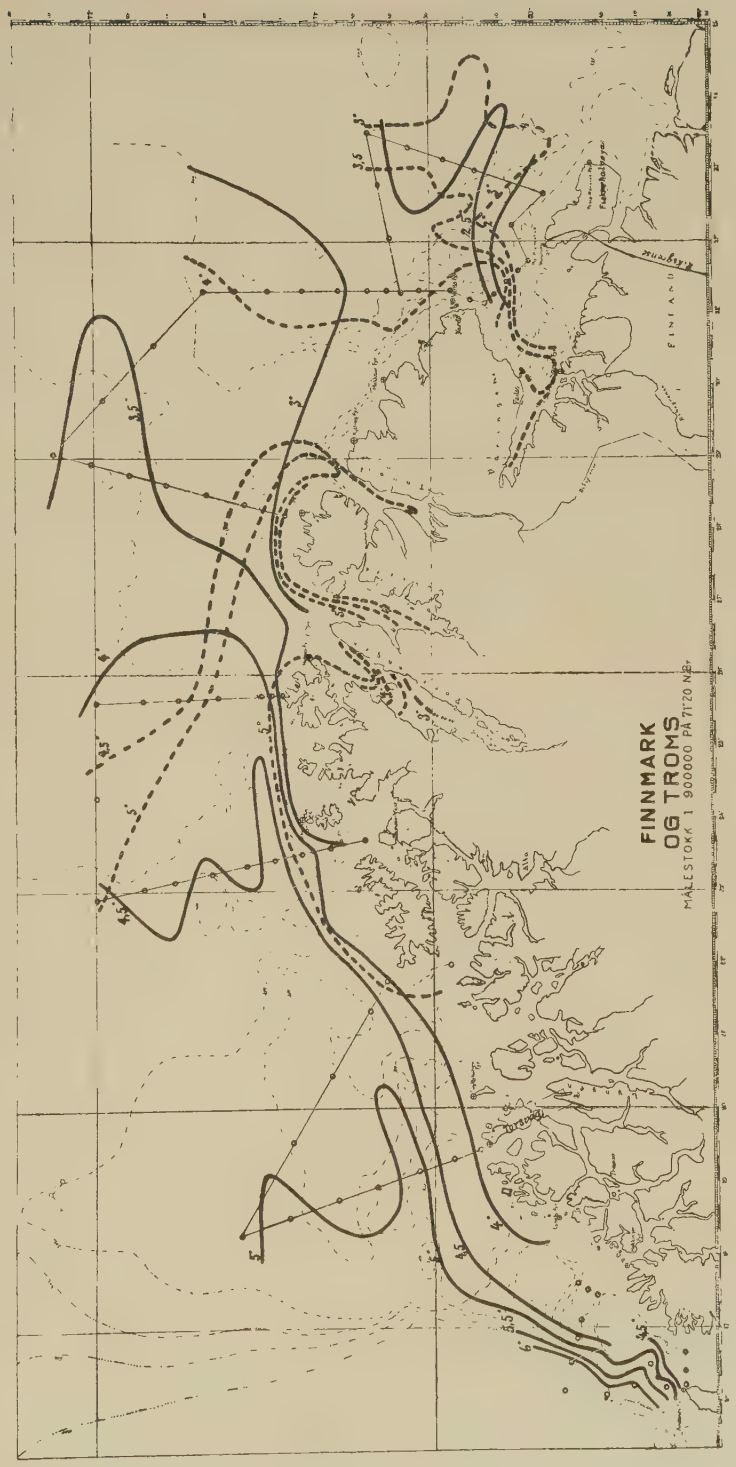


Figure 5. Temperature in 100 m. depth in spring 1936 (full-drawn lines) and in spring 1934 (broken lines). The small circles denote the net of stations.

ing temperatures during 1936 have been observed. 4 fixed oceanographic stations were established by the Fisheries Directorate along the Norwegian coast in 1935/36. Observations are made once a fortnight throughout the year. The southern station (61°04′4 N., 4°50′5 E.) records colder waters in 1936 than the deep water of the previous year, at this locality consisting of Atlantic water; this decline was continued in 1937. Thus, the temperature about new-year was 0·9° lower at 175—300 m. depth than a year before. It should be recorded, however, that the decline of deep water temperatures recorded in March/April 1935/36 was but minimal in 1937, the mean temperature for April at this station being slightly above that of 1936 and below the 1935-mean. These conditions correspond well with conditions of deep water in the northern part of the Norwegian Deep (see table 1) when the April temperature of 1937 was slightly above that of 1936, but considerably lower than the 1935-mean.

Also the Lofot-stations record decreasing temperatures in deeper layers.

Studying coastal conditions off Norway a decline in temperature in general will have been observed ever since 1934. Fig. 5 illustrates temperatures at 100 m. depth off Tromsø and Finmark and shows a decrease in temperature from spring, 1934, to spring, 1936, (corresponding observations were not made in 1935). Isotherms for 1936 are recorded by fully drawn curves, those of 1934 as broken lines. Temperatures decrease from 6° off Andenes to 2° at the Varangerfjord estuary, in 1936. In 1934, the 5°-isotherm reached as far east as the Tanafjord (29° E. Long.), in 1936 it barely reaches east of Torsvåg (20°10′ E.). In 1934, water of 3° or less was not recorded west of the SE.-port of Varangerfjord and Fiskerhalvöya, in 1936 the relatively cold 3°-water reached as far west as near the Honningsvåg (27° E.).

It is worth recording that the major part of the E.-Finmark fishery in 1934 took place as easterly as the Varangerfjord and the Fiskerhalvöya where the deep water temperature was about 3°, the fishing was only poor west of the Finmark coast. In 1936, with lower temperatures and the relatively cold 3°-limit reaching no further east than the Honningsvåg, it is a well known fact that a good fishery — the best for many years past in E.-Finmark waters — took place just as far west as the Honningsvåg. It is an obvious theory that decreasing temperature has been the cause of fishing in 1936 taking place so far west of the 1934-fishery. In Vol. 2 of "Norges Fiskerier 1936"[1]) two vertical sections are illustrated showing that Atlantic water in 1934 occupied a far larger area of the section true north of Nordkap than in 1936. The transport of Atlantic water, eastwards, in 1936 was much inferior to that of 1934 and the eastgoing heat-transport correspondingly lower in 1936. This fully agrees with — probably being the main reason of — the westward move of the comparatively cold 3°—4° isotherms in 1936 as compared to 1934.

As already mentioned, a decrease in the spring temperature of Atlantic water was found when a comparison was made of 1936 and 1935 and it has been proved that deep water temperatures have declined in the North Sea. Also salinities have somewhat decreased.

Studying the distribution of the various types of water during the two years, it will be noticed that the force of Atlantic water has decreased. In 1935 the area of the vertical section along 60°45′ N. Lat., between Shetland and Norway, covered by Atlantic water was 15·3 % larger than in 1936.

In table 2, the distribution of various types of water is recorded as area-percentages of the three sections previously mentioned. I, Shetland—Norway (60°45′ N.), II, Water Sound—Feistein, and III, the Egersund section as far as 3° E.

Table 2.

Various types of water	Sec. I		Sec. II		Sec. III	
	1935	1936	1935	1936	1935	1936
Atlantic water (> 35 ‰)	86·0 %	74·6 %	78·4 %	66·6 %	83·3 %	66·8 %
North Sea water (34 ‰—35 ‰)	10·8 -	22·6 -	15·4 -	28·7 -	9·6 -	27·7 -
Water (< 34 ‰)	3·2 -	2·8 -	6·2 -	4·7 -	7·1 -	5·5 -

It is a fact that the strength of the North Sea water has increased at the sacrifice of Atlantic water and that decreases have been recorded on the quantities of less saline water. Within the area between the latitudes of the northern point of Shetland and that of Scotland (to Norway) the quantity of Atlantic water in spring, 1936, was 1479 milliard ton less than that of 1935, — a difference corresponding to 14 %.

Calculations of water-transport and current are not to be discussed in this paper; it may be said, though, that the calculations show considerably less movement of water masses during April, 1936, when compared to those of 1935. The inflow of Atlantic water from the Norwegian Sea to the North Sea is considerably lower in 1936, thus causing a smaller quantity of Atlantic water and lower temperatures of deep water in April 1936 than the year before.

As has already been mentioned, the investigation was repeated in 1937, between April 12th and May 7th, but this year the net of stations has been extended to 139 oceanographic stations with 1123 observations. The distance between certain stations was reduced to 5 miles, in the SE. part of the Norwegian Sea the investigations were extended further west, and in north to 64° N. Lat.

[1]) Eggvin, Jens: Oceanografiske forhold i Nord-Norge under Lofot- og Finmarkfisket 1936. Bergen 1937.

12.

Fluctuation and Oscillation in a Community of Pure Spent Herrings.

By

G. Gilson, Ostend.

On previous occasions I have called the attention of biologists to a remarkable shoal of pure spent herrings that concentrates every year, from December to March, in the vicinity of the continental coast, between Cap Grisnez and the Scheldt. For seven years already we have been examining daily samples of 25 of these herrings supplied by the fishermen and we intend to continue the work for several years more.

Each fish was submitted to the eight analytical operations that are now accepted as classical.

The so-called "biological scale" of the shoal is the superposition of annual diagrams showing the percentage of individuals in each of the year-classes, in a succession of years. Every year a step is added to this scale after the closure of the fishing season and the completion of the laboratory work on the samples collected. Fig. 1[1]).

This arrangement clearly shows the annual change in the composition of the returning shoals and the sequence of the stages of increase or decrease in their evolution.

Another presentation of the data collected by the same continuous observations is given in the linear diagram, Fig. 2, in which each class is taken separately and its particular evolution made more conspicuous.

The graph, Fig. 3, shows the remarkable irregularity in the percentage of the 3-year-old recruits, — that is to say the number of 3-year-old individuals found in a lot of 100 herrings taken at random from the shoal. The variation extends from 3 % in 1933, to 28 % in 1935 — a rather extensive span of fluctuation.

The unfailing return to our shore of these spent herrings after the annual breeding is an interesting biological phenomenon and the fluctuation in the percentage of the yearly additional element seems well worth the attention of biologists.

Remarks and Suggestions.

Fluctuation.

Applied to fishes the term fluctuation should indicate a succession of yearly generations, quantitatively dissimilar, considered over a series of years.

In Fig. 1, biological scale, the fluctuation is the superposition of the yearly percentage columns in the series of years 1930—1937. Each of the 8 vertical columns shows the fluctuation of percentage for the 8 year-classes considered in the course of the 7 years of observation. In the linear diagram, Fig. 2, the fluctuation of the percentage is pointed at different heights on each of the vertical lines corresponding to the 6 age categories considered.

Oscillation.

I have proposed this term[1]), for want of a better one to indicate the rising and falling of percentages in the course of the evolution of one and the same generation considered over a series of successive years.

In the linear diagram, Fig. 2, the oscillation of each of the consecutive generations, born in the years 1927 to 1933, is marked by the dotted lines.

In the columnar diagram, Fig. 1, oscillation must be followed from one year to the next by changing column from left to right as one goes down one step.

[1]) A short legend is affixed to each annual diagram, indicating:

1) the number of herrings examined in the season; 2) the mean weight of a day's capture; 3) the total weight landed at Ostend in the season; 4) the mean value of 100 kg. obtained in the market; 5) the total value of the landing in the season; 6) the number of individuals destroyed.

[1]) G. Gilson. Further observations on Spent Herring, with Remarks on Fluctuations and Oscillation. Cons. Intern. Rapp. et Proc.-Verb. Vol. C, III, 1936.

1930—31

Number of herrings examined	1,167
Mean weight of a day's capture	8,338 kg
Total weight landed in the season	18,360,596 kg
Mean value of 100 kg	71 fr.
Total value of the season	13,008,930 fr.
Number of individuals destroyed	217,002,545

1931—32

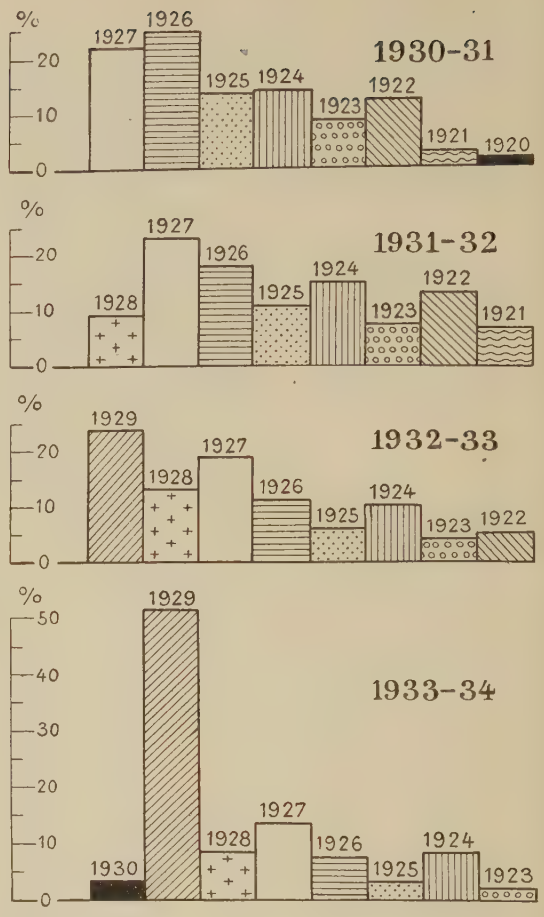
Number of herring examined	783
Mean weight of a day's capture	5,225 kg
Total weight landed in the season	3,383,750 kg
Mean value of 100 kg	108 fr.
Total value of the season	3,642,806 fr.
Number of individuals destroyed	34,992,241

1932—33

Number of herrings examined	1,000
Mean weight of a day's capture	4,514 kg
Total weight landed in the season	2,673,185 kg
Mean value of 100 kg	91.50 fr.
Total value of the season	2,446,867 fr.
Number of individuals destroyed	29,405,035

1933—34

Number of herrings examined	1,479
Mean weight of a day's capture	7,600 kg
Total weight landed in the season	7,455,800 kg
Mean value of 100 kg	75 fr.
Total value of the season	5,577,441 fr.
Number of individuals destroyed	76,861,050



Balancing of percentages: number of individuals of each year-class in 100 fishes.

Fig. 1. Percentage number of individuals in each year-class.

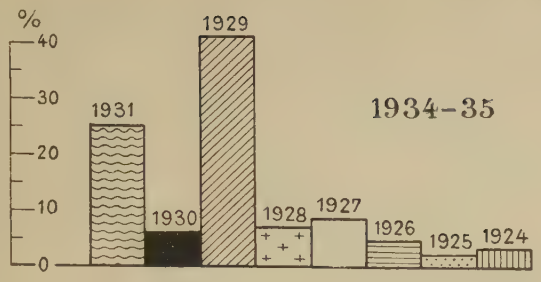
Causes of fluctuation and oscillation.

I. Concerning fluctuation I have presented last year at the meeting of this Committee, a few remarks alluding only to the two sets of possible causes of quantitative variation in general: a) internal causes tending to increase or to reduce the production of ovarian eggs and the chances of success in their fertilization, deposition and fixation on the bottom of the sea: — b) external causes, physical or biological — (temperature, salinity, pH, plankton, motion of water, meteorological conditions etc.). These may have an action first on the eggs and larvae and, later on also, on the displacement, dispersion and reconcentration of the shoals of adults, and their drifting towards the spawning and fishing grounds, or away from them.

Both internal and external causes may be investigated and used for prognostication when, some day, a regular system of continuous observations is organised in the southern part of the Flemish Sea and in the Eastern Channel.

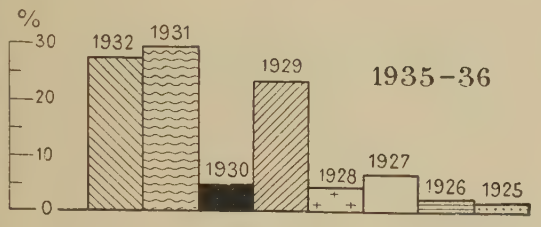
As to oscillation I have insisted, in a previous note, on the peculiar character of the quantitative evolution of all generations of our spent herrings: each of them presenting a rising, up to the age of 4 years, immediately followed by a more or less regular falling, down to extinction. — See diagram Fig. 2.

The remarkable constancy of this phenomenon leads us to consider it as dependent on an internal cause, inherent to the physiology of the fish. The fourth year seems to mark the critical age at which mortality, in a group of living organisms, being very high immediately after birth and having greatly diminished for a certain period, again becomes more intense down to the complete extinction of the group.



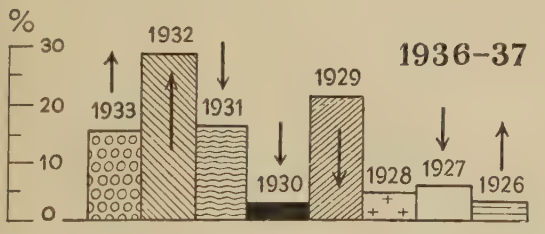
1934—35

Number of herrings examined	1,200
Mean weight of a day's capture	14,632 kg
Total weight landed in the season	12,322,990 kg
Mean value of 100 kg	31.52 fr.
Total value of the season	3,856,044 fr.
Number of individuals destroyed	123,553,199



1935—36

Number of herrings examined	1,300
Mean weight of a day's capture	11,120 kg
Total weight landed in the season	8,595,895 kg
Mean value of 100 kg	62 fr.
Total value of the season	5,328,754 fr.
Number of individuals destroyed	81,965,880



1936—37

Number of herrings examined	625
Mean weight of a day's capture	7,319 kg
Total weight landed in the season	3,132,460 kg
Mean value of 100 kg	72 fr.
Total value of the season	2,258,225 fr.
Number of individuals destroyed	31,211,269

Age-groups: III IV V VI VII VIII IX X

Number of herrings examined in 7 years. 7,554

Balancing of percentages: number of individuals of each year-class in 100 fishes.

Fig. 1. Percentage number of individuals in each year-class.

The problem ought to be studied in larger communities than the small shoal of our coast, and attention should be paid to the possibility of outer agencies influencing either the ascending or the descending part of the oscillation, and it should be kept in mind that all figures in our diagrams being percentages, a change in one of them must affect all the others proportionately and inversely. I have given, in 1931 and 1935 several illustrations of this phenomenon which I have called "Balancing of percentages". It has sometimes escaped the attention of biologists and led them to erroneous conclusions.

Forecasts.

In 1935—36 our previsions for 1936—37 were that good shoals might be expected. These predictions were based on the fact that two classes, 1931 and 1929, that had played an important part in the good season 1934—35, would be present with a high percentage, one of them, 1931, being then only at the first stage of reduction and the other being the famous class at 1929 and expected still to show a good percentage in 1936—37. Beside that, there would be a young class, 1932, appearing at 3 years with the highest percentage recorded, and entering in 1935—36 the augmentative stage of 4 years of age.

Qualitatively the prediction was rather successful: see step 1936—37 in the biological scale, Fig. 1, — although the column of 1931 had a greater reduction than expected. There was no disagreement concerning percentages.

But quantitatively, on the other hand, the season was very bad and the forecast was quite wrong. The density of the shoal was among the lowest recorded in 7 years of regular observation: the mean weight of a day's capture being only 7,319 kg., whilst the season

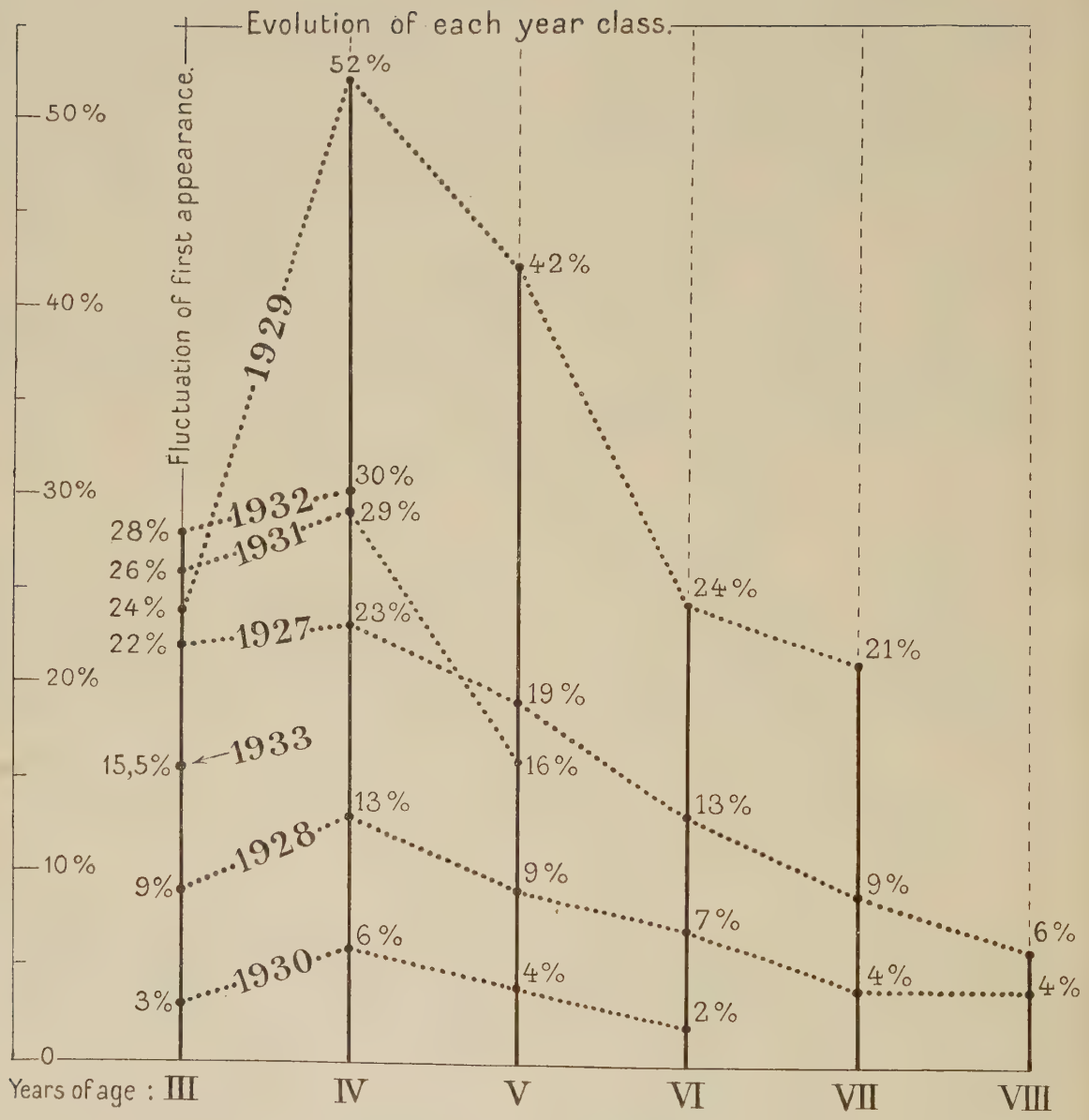


Fig. 2. Vertical lines = fluctuation. Dotted lines = oscillation.

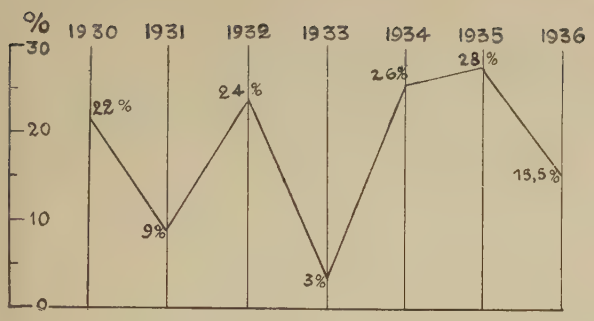


Fig. 3. Fluctuation at first appearance of 3-year-old recruits.

1934—35, in which the two classes 1931 and 1929 had played an important part, had the highest record hitherto obtained: 14,632 kg. for one day's fishing and consequently its shoal must have been very dense.

The fishing in 1936—37 was a failure and, although the market prices were high: 72 Fr. per 100 kg. — the fishermen were disheartened and gave up fishing with the herring trawl.

The spents were a little more abundant close to the shore, in French territorial waters, but there also, — with drift nets, the only net allowed by French law within the 3-mile limit — poor catches were the rewards to the fishermen.

This failure of the quantitative forecast is very remarkable and instructive. It shows that data taken from the percentage only, even when completed with the notion of the density of shoal, are insufficient for reliable forecasts. We want information about the fate of the shoal of spents after they have left our shores, and that can scarcely be expected except from a continuous service of a complete and periodical scientific survey of the region.

As a further trial of the value of the method of percentages, we deduce from the step 1936—37 of the biological scale, that the new shoal of 1937—38 will show a majority of herrings of the V and VI-group with a remnant of year-class 1929, the VIII-group, and perhaps a good percentage of the new 1933-year-class.

Quantitatively, from percentages, the prognostics are rather bad, all classes being, in 1937—38, in stages of reduction, except the new class, 1933, which will be in augmentation and may, perhaps, save the situation.

13.

Observations on Length, Age Distribution and Growth of Herring in the Flemish Bight and off Dieppe 1936—37.

By

J. J. Tesch, 's Gravenhage.

In the winter 1936—37 again we investigated herring of the East-Anglian fishery and of the eastern part of the Channel.

The samples we got in the early half of October 1936, unfortunately, were not from these regions but were caught off Shields. From medio October, however, till the end of November we examined samples regularly from Smith's Knoll; after November the fishery shifted to the neighbourhood of Dieppe where it remained until the beginning of February, 1937. Each week we received a sample of about 200 specimens.

Our material, thus, originated from three sources: at first from the waters off Shields (a rather insignificant part of the whole lot), secondly from the Flemish Bight, and thirdly from the fishing grounds off Dieppe. The usual observations were made on length, maturity, vertebrae and age.

It is not intended here to deal with racial investigations but rather to treat the whole material as belonging to one population, with the exception of two samples from Shields. A few words may suffice here to characterize these latter individuals. As proved by their vertebrae they belonged definitely to the Bank herring race and many of them showed signs of an autumn-spawning race in which spawning activity was dwindling: out of 330 individuals 40 % were spent, and, as usual at the end of a spawning period, older individuals predominated, the chief ages being 4, 5 and 7 years, with 19·1 %, 23·7 % and 29·8 % respectively.

The majority of the remaining samples, from medio October onwards, were taken by the Dutch standard nets[1]), and thus we may assume that the results with regard to length and age are comparable.

I. Length. The average length of our herrings during last winter was 25·70 cm. and exceeded that obtained in the preceding winter (24·98 cm.) by nearly 0·75 cm. That the fishes generally were larger is shown by the graph in Fig. 1. Here the length-frequency of the herring during the winter of 1935—36 is represented by the continuous curve, whilst the broken curve indicates this frequency during the winter of 1936—37. This last curve culminates at 25 and has a slight bulge at 27 cm., but the lengths of 20—22 cm. are almost entirely lacking, indicating the failure of some young year-class.

The length-frequency (in thousands) in this and in the preceding winter was as follows:

Table I.

cm	20	21	22	23	24	25	26	27	28	29	30
1935—36	3	16	65	136	192	174	175	168	59	10	2
1936—37	—	—	10	34	146	279	234	196	82	15	3

Examination of the length-frequency curve reveals at first sight that things in winter 1936—37 are merely the continuation of those in the preceding winter and that there is no indication of recruitment of the stock. We wish to emphasize this point from the outset.

[1]) Length of net 620 meshes, depth 340 meshes; 34½ knots per yard.

II. Age Assessments. From the middle of October 1936 to the beginning of February 1937 we ascertained the age of 2961 individuals, not counting a few in which the scales were unreadable.

The percentual age-frequency of the whole material was as follows:

Table II.

Age...	3	4	5	6	7	8	9	10 and+
Year of birth..	1933	1932	1931	1930	1929	1928	1927	1926
%....	2·63	36·58	25·77	11·55	17·63	3·51	1·86	0·47

These percentages are illustrated in Fig. 2.

year-class, now 7 years old, which is still an outstanding one.

As stated before there are in the material two different sources of origin: the first is the Flemish Bight, from middle of October to end of November, the second the grounds off Dieppe, during the period December to beginning of February.

In the first set of samples the maturity was stage V in about 90 %, with an occasional sprinkling of stage VII; in the second set the herrings were either full or spent (stage VI or VII). It has been often noticed that at the beginning of the East-Anglian fishing the younger year-classes appear, afterwards followed by the older ones. This rule has been observed again in

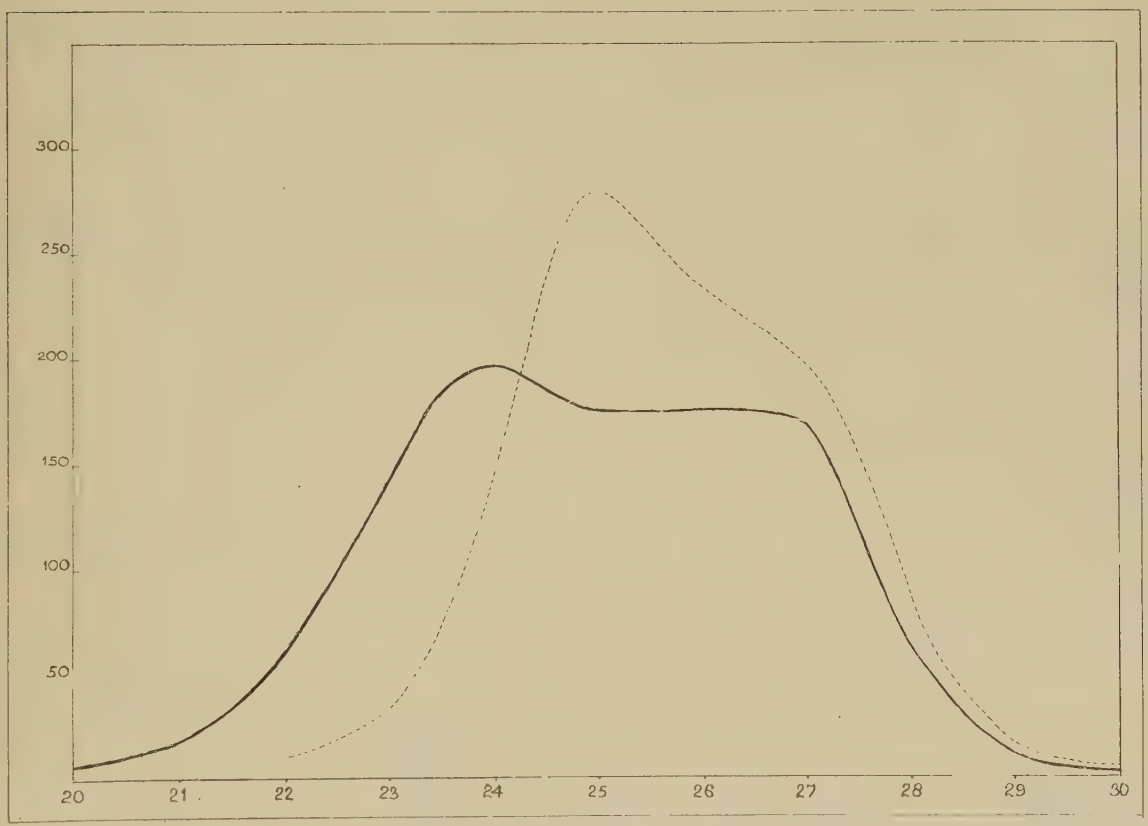


Fig. 1. Length-frequency curve of herrings in the Flemish Bight and off Dieppe. Continuous curve:— winter 1935—36, broken curve:— winter 1936—37.

In the first place the deficiency of the 1933 year-class is very striking. It looks as if the productivity of the herring after the two abundant broods of 1931 and 1932, already formerly recorded and here appearing as "fives" and "fours" respectively, has exhausted itself (or, more likely, that adverse circumstances have inordinately diminished the brood at the outset). Furthermore there is still the 1929 our first period of sampling (in the Flemish Bight), though in no case the three-year-olds were of any account; but off Dieppe the predominance of young fishes ("fours" and "fives") remained throughout the period of fishing. We refer to the following table in which the percentual age distribution for each fortnight has been recorded.

Circumstances beyond Cape Gris Nez may have

been different from those of the preceding season, as we at that time in the preceding year found the same gradual substitution of younger year-classes by older ones as in the East-Anglian fishery[1]). But it must be borne in mind that we had to put a stop to our investigations of this season at the beginning of February already, whereas in winter 1935—36 we continued right up till the end of that month.

actually found (Fig. 2), we may say that there is rather a good agreement especially so in the case of the samples from Dieppe. The "fours", however, fell far short of the forecast and the "sixes" and "sevens" turned out to be more numerous than was anticipated.

That the theoretical percentages agree to such an extent with the ones actually found is of course

Table III.

Age	3	4	5	6	7	8	9	10 and+
15.—31.X.	1·7	56·8	27·1	3·2	9·6	1·—	—	—
1.—15.XI.	1·—	27·1	24·1	15·1	25·—	5·2	1·—	1·—
16.—30.XI.	1·3	9·7	16·6	25·—	33·—	6·6	6·5	1·—
Flemish Bight 15.X.—30.XI. Total	1·43	31·34	22·66	14·83	22·49	4·3	2·28	0·67
1.—15.XII.	3·8	40·6	24·7	11·—	13·7	4·2	2·—	0·2
16.—31.XII.	4·3	42·56	29·24	8·8	12·8	1·—	1·—	0·1
1.I. -4.II.	2·5	42·—	32·—	5·—	13·5	2·5	2·5	—
Off Dieppe 1.XII.—4.II. Total	3·62	41·71	28·19	9·1	13·33	2·54	1·59	0·13

III. Forecast of percentual age distribution of 1936—37. In the paper last quoted we did not commit ourselves to any prediction on the base of the findings during the winter 1935—36 for the next season. However, such a forecast was given by the present writer in a small treatise on the subject in September 1936[2]). The theoretical percentages for the season 1936—37 are here given in Table IV, together with the empirical ones.

Comparing the percentages here given *inter se* and looking at the figures of the theoretically calculated age distribution for 1936—37 (Fig. 3) and the one partly accidental. We cannot as yet foresee the strength of the three-year-olds in any forecast[1]), and the fact of their practical failing in the shoals in our samples contributes likewise to the great conformity of Fig. 2 and Fig. 3.

The characteristics of the season 1936—37 were therefore:

a) Deficiency of the year-classes 1933 and 1930.
b) Abundance of the year-classes 1932, 1931 and 1929.

[1]) Rapp. et Proc.-Verb., Vol. C, III, 3, 1936.
[2]) 1r Congrès International de la Mer, Ostende 1936, p. 371.

[1]) An attempt to find a correlation between the abundance of herring brood and barometric pressure has been made by Carruthers and Hodgson (Rapp. et Proc.-Verb., this Vol., No. 4).

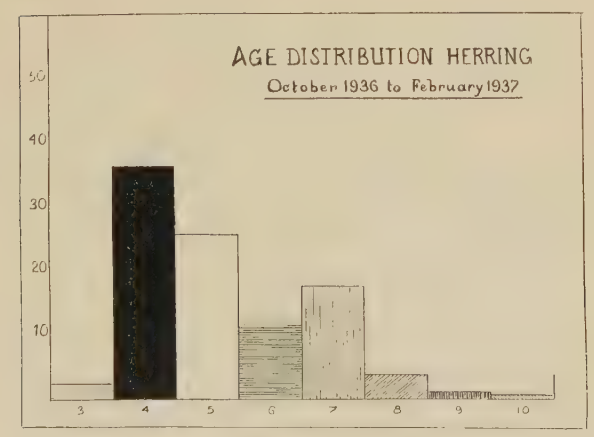


Fig. 2. Percentual age distribution of herrings from the Flemish Bight and off Dieppe taken together (October 1936 to February 1937).

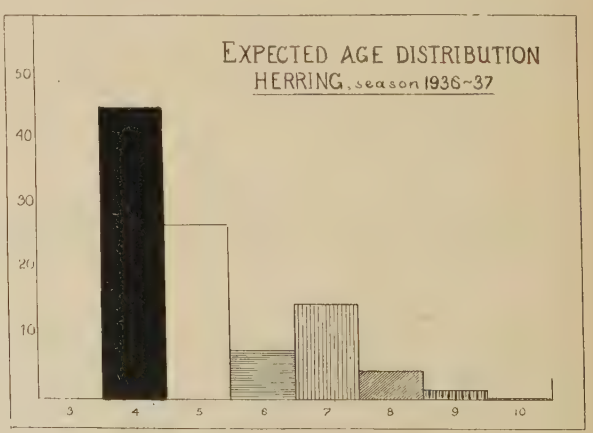


Fig. 3. Theoretical age distribution of herrings for the season 1936—37, largely in accordance with the actual one (Fig. 2).

Table IV.

Age	3	4	5	6	7	8	9	10 and+	Total
Actual numbers found in 1935—36	574	1022	379	792	265	135	43	—	3210
Theoretical numbers expected in 1936—37	?	1665	978	274	538	152	59	13	3679
%	?	45·26	26·58	7·45	14·62	4·13	1·6	0·35	..
Actual percentages found from 19.X. 36—4.II. 37 (see Table II)	2·63	36·58	25·77	11·55	17·63	3·51	1·86	0·47	..
Actual percentages off Dieppe 1.XII. 36—4.II. 37 (see Table III)	3·62	41·71	28·19	9·1	13·33	2·54	1·59	0·13	..

IV. Growth. In the following table the growth of the various broods represented in our samples is given for the last three winters.

It is of course obvious that the average length of the youngest year-class in our samples of drift-net herrings is always too high, as these nets are largely selective for the smallest fishes caught. In the present case moreover too few of the youngest fishes were available.

The most striking difference is the rather large size attained by the "fours" during last winter. In the older year-groups (from the seventh onwards) there seemed to be a general tendency of a lowering of the average length (especially in the ninth), but much weight should not be attached to this.

Table V.

Age	3	4	5	6	7	8	9	10 and+
Average length in cm.								
1934—35	23·13	24·41	25·40	26·26	26·76	27·30	27·77	28·14
1935—36	23·06	24·18	25·50	26·27	26·93	27·28	27·89	28·33
1936—37	23·17	24·98	25·46	26·42	26·70	27·18	27·28	28·16

14.

The Protection of Sturgeon, Salmon and Sea Trout in the Vistula.

By

M. Siedlecki.

The fishery for Salmon, Sea Trout and Sturgeon in the Vistula and near its estuary has been decreasing considerably in later years. The sturgeon has become an extremely rare fish; the salmon (*Salmo salar*), although playing a very important role in the Polish sea fishery, was rarely caught within the Vistula or its by-rivers; the sea trout, not very important to the Polish sea fishery but of great value for the fishery in the Vistula, both in Poland and in the Free Port of Danzig, has become far less abundant since the beginning of the present century. Especially in the upper part of the Vistula and by-rivers belonging to the system of this river, where the spawning grounds of the salmon and the sea trout are situated, the quantity of mature fishes has diminished to such degree, that the artificial propagation of these species becomes difficult from lack of sufficient spawners.

A small committee of experts was appointed by the authorities of Poland and of the Free Port of Danzig to study the methods of protection of the three species. This committee met in Krakow and examined the following questions:

1) Sturgeon (*Acipenser sturio*).

This valuable fish was fairly abundant in the Vistula some 60 years ago. In the last 20 years the sturgeon has gradually disappeared, as shown in Tables I and II.

Table I. Catch of Sturgeon in the lower Vistula, 1919—1932. (After Kulmatycki).

Month	IV		V		VI		VII		VIII		Date of catch not known		Notice
Year	kg.	spec.	kg.	spec.	kg.	spec.	kg.	spec.	kg.	spec.	kg.	spec.	
1919	110	1	82	1	..	..	..	..	..	..	..	..	
1920	..	..	117	1	..	..	..	..	..	..	..	..	
1921	..	..	..	..	..	..	..	..	..	..	..	..	
1922	..	..	..	..	100	1	154	2	..	..	..	..	
1923	180	1	..	..	..	..	83	1	..	..	..	..	
1924	..	..	..	..	..	..	200	2	..	..	..	..	
1925	..	..	190	2	210	2	..	..	..	..	..	..	
1926	..	..	..	..	84	1	..	..	..	..	402	5	
1927	..	..	210	2	117	1	..	..	..	..	..	..	
1928	125	1	..	..	85	1	117	2	..	..	307	4	
1929	..	..	..	..	89	1	..	..	70	1	232	2	
1930	100	1	202	2	101	1	60	1	..	..	105	2	
1931	..	..	283	2	291	3	123	1	..	..	..	..	mature females
1932	..	..	670	6	102	1	..	..	..	..	..	..	—
Total...	515	4	1754	16	1179	12	737	9	70	1	1046	13	

Table II. Catch of Sturgeon in the lower Vistula, 1928—1935. (From official statistical Figures.)

Month	IV		V		VI		VII	
Year	kg.	spec.	kg.	spec.	kg.	spec.	kg.	spec.
1928	..	..	..	..	272	1	..	..
1929	..	..	75	1	239	1	70	1
1930	..	..	..	..	..	..	..	..
1931	..	..	..	..	..	..	..	..
1932	98	1	460	6	203	3	118	1
1933	250	2	230	2[1])	140	1[1])	130	1
1934	83	1	..	..	..	..	..	..
1935	..	..	..	..	..	..	..	..
Total	431	4	765	9	854	6	318	3

[1]) In May and June mature females.

The figures in Table I were provided chiefly by private persons, Table II is compiled by local authorities. Probably the tables are based on different observations; if therefore we add the quantities shown in both tables, we obtain figures roughly corresponding to the actual state of the sturgeon fishery in the Vistula. In 17 years less than 80 specimens of sturgeon were taken in the Vistula by the Polish fishermen or 4 specimens per annum only.

In the Baltic the sturgeon is caught occasionally only and near the Polish shore; according to the official statistics, since 1928 very few specimens only were recorded.

The sturgeon thus may be regarded as a species very near to complete extinction being rather a natural monument than an object of fishery. For this reason, and following the ideas often expressed in the Salmon and Trout Committee, the experts from Poland and from the Free Port of Danzig, where similar observations were made, agreed unanimously that the sturgeon should be protected in the most efficient way. A complete prohibition of fishery for sturgeon was introduced in the territories of Poland and of the Free Port of Danzig for a period of three years beginning with the autumn of 1936.

2) Salmon and Sea Trout.

During the above-mentioned meeting of experts from Poland and from the Free Port of Danzig the experts came to the conclusion, that the protection of the salmon and sea trout in the Vistula was insufficient. The changing conditions of the rivers as a consequence of the development of industry, and the intensification of the fishery form a serious danger to these valuable species of fishes and a more effective protection is needed. Hitherto both species have been well protected during the spawning season only by suitable close times. But in the Vistula, a river, where the migratory fishes, going to the spawning places, travel about 1000 km., it is necessary to protect the salmon and the sea trout also when entering the river, during their slow migration, and at the spawning places.

The statistical figures in Table III show that, in the lower part of the Vistula, the main run of salmonoid fishes occurs late in the autumn (November and December). A second, but only a small run can be observed in spring, chiefly in April. Similar runs were observed on the territory of the Free Port of Danzig.

The upstream migration proceeds slowly and the fishes arrive at the spawning grounds before the next summer.

The conference of experts came to the conclusion that salmon and sea trout should be protected in a way corresponding to their biology and their migrations. By common agreement the Governments of Poland and of the Free Port of Danzig published in 1936 suitable regulations for the protection of the

Table III. Salmon and Sea Trout Fishery in the lower Vistula (718—914 km. from the Sources), 1928—1935. Quantity in kg. Year 1931 omitted because of high Floods. (From official statistical Figures.)

	1928 Vistula 718-914 km.		1929 Vistula 718-914 km.		1930 Vistula 718-914 km.		1932 Vistula 718-914 km.		1933 Vistula 718-914 km.		1934 Vistula 784-914 km.		1935 Vistula 847-914 km.		Total without 1931	
Month	kg.	%	kg.	%	kg.	%	kg.	%	kg.	%	kg.	%	kg.	%	kg.	%
I	—	—	180	3	65	2	890	9	100	2	600	8	2850	17	4685	9
II	—	—	—	—	50	1	20	—	—	—	200	3	2100	13	2370	4
III	250	5	—	—	530	17	—	—	280	5	580	7	930	6	2570	5
IV	180	4	1190	20	415	13	110	1	370	6	320	4	530	3	3115	6
V	340	7	680	11	155	5	320	3	340	6	70	1	280	2	2185	4
VI	400	8	300	5	—	—	130	1	130	2	200	3	420	2	1580	3
VII	280	6	600	10	545	18	130	1	210	3	800	10	980	6	3545	7
VIII	830	18	890	14	240	8	690	7	410	7	810	10	800	5	4670	8
IX	440	10	500	8	115	4	600	6	410	7	630	8	1370	8	4065	7
X	550	11	720	12	..	..	1130	11	580	10	490	6	1360	8	5180	9
XI	890	19	360	6	1045	33	4260	44	2660	44	1530	19	2880	17	12930	24
XII	590	12	680	11	..	..	1680	17	510	8	1670	21	2200	13	7680	14
	4750	100	6100	100	3160	100	9960	100	6000	100	7900	100	16700	100	54575	100

salmon and sea trout corresponding to the opinion of the meeting of experts as follows:

A. Poland.

Ordinance of the Minister of Agriculture from September 24th, 1936, concerning the Protection of Sturgeon, Salmon and Sea Trout in the Vistula and her By-Rivers.

On the base of article 54, item 1, point 1 of the Fishery Law of March 7th 1932 (Journal of the Laws of the Polish Republic, Nr. 35, point 357), I give the following ordinance:

1.

The complete prohibition of the fishery for sturgeon is introduced.

2.

(1) The prohibition of fishery for salmon and sea trout is introduced at the following seasons:

1) in the province of Pomorze[1]) — from December 10th to January 10th and from April 15th to May 31st;

2) from the limit between the province of Pomorze and the province of Warszawa to the mouth of the river Sanna going to the Vistula[2]) — from April 15th to May 31st;

3) from the mouth of the river Sanna to the limit of the province of Polish Silesia[3]) — from April 15th to May 31st and also from October 1st to December 31st.

(2) The ordinance in item (1) does not concern the fishing for sport by rod and line.

3.

The present ordinance takes effect as from October 1st 1936 and is applicable until September 30th 1939. For this period be suspended the validity of § 2 item 1 of the ordinance of the Minister of Agriculture of October 27th 1932 concerning the protection of fishes and crustaceans in the open waters and regarding the protection of sturgeon, salmon and sea trout in the Vistula and her basin.

[1]) In the northern part of the Vistula, from the frontier of the territory of the Free Port of Danzig.

[2]) The middle part of the Vistula.

[3]) The upper part of the Vistula and by-rivers, where the spawning grounds are situated.

B. Free Port of Danzig.

Ordinance of the Police of Danzig from August 18th 1936 concerning the protection of salmon, sea trout and sturgeon (Staatsanzeiger für die Freie Stadt Danzig, part. I from August 26th 1936, No. 92, item 342).

On the base of §§ 106 and 107 of the Fishery Law of May 11th 1916 (Z. U. page 55) and §§ 136 and 140 of the Law Concerning General Administration of the Country of July 30th 1883 (Z. U. page 195) the following ordinance of the Police is published:

1.

For a period of 3 years the time of protection for salmon, sea trout and sturgeon is established.

2.

In the Vistula in the precinct of her estuary the fishery for salmon, sea trout and the landing of these species of fishes is prohibited in the period from December 10th to January 10th and from April 15th to May 15th of every year.

3.

The fishery and the landing of sturgeon in the whole precinct of the Free Port of Danzig is prohibited in the period from October 1st 1936 to September 30th, 1939.

4.

The trespassing of the present ordinance of the Police will be punished after § 128 of the Fishery Law.

5.

The present Police ordinance takes effect on October 1st 1936 and expires on September 30th, 1939.

The introduction of ordinances concerning the fishery for sturgeon, salmon and sea trout in the whole length of the Vistula and in the sea near the estuary of that river will give protection to the three species on two different territories according to the same principles.